SCIENTIFIC AMERICAN SUPPLEMENT. No 1011

Scientific American Supplement, Vol. XXXIX. No. 1011. Scientific American, established 1845.

NEW YORK, MAY 18, 1895.

Scientific American Supplement, $5 a year. Scientific American and Supplement, $7 a year.

NICOLAS PIKE.

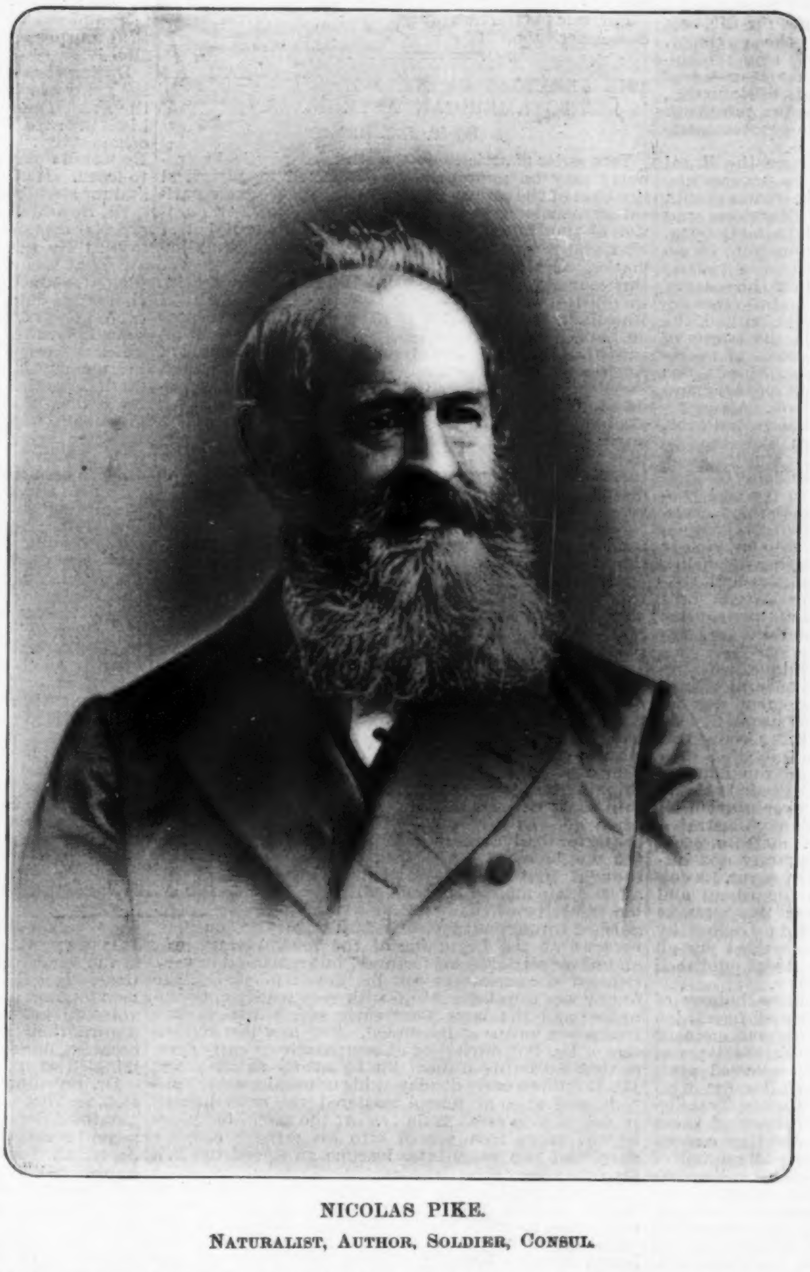
NATURALIST, AUTHOR, SOLDIER, CONSUL.

NICOLAS PIKE was born in Newburyport, Mass., in 1818. His father, Joseph T. Pike, was the son of Judge John Pike, of Somersworth, N. H. His grandfather was the Rev. James Pike, himself a son of the Rev. John Pike, descended from the original stock of the Pikes that came over from England in 1635, an officer in the British army. Among the men of the Pike family of past generations were many distinguished in civil and military life. Suffice it to mention Major Robert Pike, chief of the eastern forces in 1689; the gallant Major John Pike who was killed in the Indian wars; General Zebulon Pike, explorer and brave soldier, the discoverer of Pike's Peak, killed at the battle of York, Canada. His great-grandfather, the Rev. John Pike, presided, and preached to the Conference of Ministers of the New England Colonies, and the sermon is a family possession. For four generations the Pikes have sent a son to Havard College, where all have taken high honors. Nicolas' father was a captain in the army in 1812, and had for his orderly Sergeant George Peabody, who became the famous philanthropist and banker, and with whom a sincere friendship always existed. His mother was a descendant of the Earl of Somerby, who came to America in 1634. The maternal side claims kinship also with many of the worthiest of the land. This lady was of Scotch extraction and a Gordon by name, a most devoted Christian and beloved by all who knew her. His uncle, Nicolas Pike, for whom he was named, was the author of Pike's Arithmetic, so notable in its day that a highly complimentary letter was written to him by General Washington, still an heirloom in the family.

The subject of this memoir was the fifth son of a family of eleven children. To the age of 12 years Nicolas attended a private school, when he entered the Latin high school with a view of continuing his studies later at college. There were many among his schoolmates who have since become prominent men. Among them may be mentioned William Cushing, brother of Caleb, afterward Mayor of Newburyport; Nathaniel Daniels, editor of the Boston Transcript; the Clarks, who all became celebrated divines; Nat. Jackson, our brave general, "Old Ironsides;" Arthur Gilman, the historian and poet, and many others who became celebrated in after life. Though Nicolas studied hard at school, every chance he got was spent in the still more ardent and general study in the field. Very soon the study of nature superseded that of Virgil, and he found the prospect of a college life little congenial to his tastes. His own wish was to enter the regular army, and a commission was offered his father for him in the 6th Infantry of the United States. Friends, however, persuaded him to enter into mercantile pursuits, and he left home for Boston, and later came to New York. In 1839 he finally settled in Brooklyn, L. I., where he has since resided when in America. Business prospered with him, and in 1846 he married a charming young lady of wealthy English parents, by whom he had three sons and a daughter. Though pursuing his business avocations with diligence, yet he neglected no opportunity of identifying himself with the best interests of the city, and especially in everything of a scientific nature. He was one of the first to collect the marine flora of the North American coast, and assisted Professor Harvey, of Dublin University, Ireland, and Professor Bailey, of West Point, contributing considerably to Professor Harvey's great work, the "Neries Borealis Americana." In 1848 he was elected vice-president of the Mendelssohn Society, of Brooklyn, then a very large and active musical organization which finally merged into the Academy of Music. He was elected captain of the Light Guard, an old crack corps of Brooklyn, and is now one of the oldest living members of the Old Guard, of New York. He assisted actively in the organization of the 13th Regiment of Brooklyn, and in securing the old City Hall, corner of Cranberry Street, as an armory for the military, the first in Brooklyn. In 1849 he was elected president of the Microscopical Society, of Brooklyn, also vice-president of the Scientific Club, of New York. In 1849 Mr. Pike was elected president of the Natural History Society, which included many well known names in science, and was an indefatigable worker in its interests.

Soon after he was made a director of the Brooklyn Institute. Many were the contributions at this time from his pen to various newspapers and magazines. He studied and practiced the daguerreotype process of taking pictures, and photography, then in its earliest stages, had the deepest interest for him. He was soon after elected vice-president of the New York Photographic Society, under Professor John W. Draper. In 1852, through the kind offices of Honorable Daniel Webster, then Secretary of State, an old friend of his father, Mr. Pike was appointed United States consul general to Portugal. There he went through the usual routine of official business to the entire satisfaction of his government. Soon after his appointment he set to work collecting seeds of various vegetables, cereals, etc., for trial in America, and sent home a species of a quick-growing olive tree to be introduced into the Southern States, accompanied by a report on its cultivation, method of pressing the oil out, etc. On visiting the various consulates under his control he noticed with regret the devastation the Oidium Tuckerii, or grape disease, was slowly spreading over the land. After studying the subject considerably, the Portuguese government requested him to visit the upper and lower Corgo wine districts, and examine into the disease then threatening all the valuable wine districts of Europe. The result was a very lengthy scientific report, with plates, showing the disease in all its stages, insects, etc., which was forwarded to Washington and published by the United States government. Copies were presented to the Portuguese government, and later to the French government, and complimentary letters of thanks were received from both. The pamphlet was so well received in England that Mr. Gashiot, president of the Royal Society, of London, made copious extracts from it to embody in his report to the society. Mr. Pike was the first to recommend sulphur for the vine disease in the large district of the Douro, little thinking then, when it was timidly tried with doubts and fears, how world-wide a use the remedy would have in the future. In 1854 he was elected vice-president of the Society for the Better Condition of the Slave, Paris, France. In 1855 he was elected an honorary member of the Institute d'Afrique, Paris, France. In 1856 he was unanimously elected corresponding member by the fellows of the Zoological Society, of London, of which Prince Albert was president. In the same year he was made vice-president Honoraire de la Societe Universelle pour l'Encouragement des Arts et de l'Industrie, Torrington Square, London, in a handsome letter from the Count Brignolia. In 1859 he was appointed by the Portuguese government one of the principal jurors of the Grand Portuguese Universal Exposition, being the only foreigner on the board, the others being noblemen of distinction, including Dom Fernando, the queen's husband. On the distribution of medals he was appointed chairman of the jurors. During his residence in Portugal he opened correspondence and exchanges with many of the leading naturalists of Europe, and added largely to his collections of natural history. In 1856 he was elected vice-president of A Real Sociedado Humanitaria, Oporto, Portugal.

Just before the breaking out of the war Mr. Pike returned to America, bearing with him the good wishes of those with whom he had so long resided, from King Dom Fernando downward. Not alone were the good wishes showered on him, but a handsome service of silver plate was presented to him on his departure from the country. Very soon after his return to his native land the civil war broke out in all its fury, and true to the military instinct and patriotism of his family, Mr. Pike at once tendered his services to the government, which were accepted. He immediately set to work recruiting troops, frequently addressing large assemblies of people to induce them to volunteer to defend their country's flag. He took charge of a camp of instruction at Williamsburg, where he prepared and drilled the newly elected volunteer officers and men of the various regiments. He received a commission as lieutenant-colonel of the Calcium Light Engineer Corps, raised by special order from the Secretary of War of the United States; pay of officers and men the same as those of the regular army. This regiment he partially raised and drilled. Notwithstanding his arduous military duties, he still found time to carry on one of his favorite pursuits, and was elected president of the Photographic Society, of Brooklyn. He gave lectures on photography and the chemistry of the art, and instructed a school of young officers about proceeding to the front to attach themselves to the staff of general officers in photographing battle scenes, forts, earthworks of the enemy, etc. In the fall of 1865 Colonel Pike addressed the Long Island Historical Society on the influence of light reflected through colored mediums on vegetation. He showed experiments made on the growth of different cereals under different colored glasses, especially noticing the quickening influence of blue glass, many years later made so prominent a subject and created such a furor. In November, 1865, he donated to the Long Island Historical Society his large and valuable collection of marine plants, in sixteen folios—the labor of twenty-five years, representing the marine flora of a coast line of over 20,000 miles, containing many thousands of specimens; a costly herbarium of ferns of Long Island



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and Portugal; a collection of zoophites, and a very nearly complete one of the birds of Long Island, with many works on natural history.

In 1866 Colonel Pike was appointed one of three commissioners to examine the electric apparatus for lighting the capitol at Washington, D. C., before it was accepted by the government. The other two members were Professor S. F. B. Morse and Colonel Schaffer, United States Army. The former gentleman was ill and could not serve. Business arrangements prevented Colonel Schaffer from serving. Colonel Pike alone made a very careful examination of the work, in all its detail, and on the evening of the day he finished his labor of inspection the capitol was lighted from the basement to the "tholus" for his inspection. His report was very full and satisfactory, and was favorably received by the congressional committee, and accepted by Congress.

In 1866 Colonel Pike declined the United States consulship to Amoy, China, but shortly after, owing to the death of his wife, he accepted the consulship to Mauritius and its dependencies. He arrived at his post at a most unfortunate time, January, 1867, when a terrible epidemic fever was raging throughout the island, and a month or so after his arrival was spreading death and desolation with frightful virulence. When every one that could fled from Port Louis, Colonel Pike remained at his post, administering to his sick countrymen, many of whom died. He was at last struck down himself and constant relapses nearly cost him his life. After his recovery he forwarded to Washington an exhaustive and valuable report on the epidemic, published in the Report of the Department for Foreign Relations.

In 1866 he was appointed corresponding secretary of the Long Island Historical Society, Brooklyn, L. I. Same year elected corresponding member of the Ethnological Society of New York. In 1868 he received a medal from the Royal College, Mauritius, for the best collections in zoology, presented by the governor. This medal was the largest one ever given by the college. In 1868 he was unanimously elected vice-president of the Royal Society of Arts and Sciences, of Mauritius. The governor, by virtue of his office, is the president. Colonel Pike considers this one of the greatest compliments ever paid him.

In 1869 he received another medal from the Royal College for the best general collection in natural history. In the same year Colonel Pike, in company with Sir Arthur Gordon, then governor of Mauritius and its dependencies, was invited by Rear Admiral Coburn, then in command of the East Indian squadron, to accompany him on board the frigate Forte on a visit to the Seychelles group of islands, lying off the coast of Africa. The invitation was accepted, and the visit occupied about forty days. Colonel Pike visited the whole group, walking over and through the forests of many of them, making notes and collections of everything of interest. His report on these islands was published in full by the Royal Society of Arts and Sciences, and afterward in pamphlet form. A long report was made of the marine flora to the government, together with many specimens which were sent to England. Soon after his arrival in Mauritius the great abuses on board whaleships became evident to him, and he set to work with a bold hand to try and protect that ill-used class, the crews of whaleships cruising in the Indian Ocean, over which he had jurisdiction. Of course he was met at every step by violent opposition from those interested in keeping up such a disgraceful state of affairs, but his lengthy and continuous dispatches to the government attest how earnestly and persistently he strove in the cause. But by firm and resolute conduct he was enabled to combat them successfully.

Though leaving no official duty undone, with renewed health the old ardent thirst for natural science again burst forth, and every leisure moment was devoted to making valuable collections of natural history and procuring information on everything connected with the island, which was later on embodied in a work called "Sub-tropical Rambles in the Land of the Aphanapteryx," to be followed by a second volume on the "Fauna and Flora," the first ever written on the island. The first volume was profusely illustrated and contained valuable maps and meteorological charts. This work comprises the geography and history of the island, with a full account of sugar, its culture and manufacture, a tour round the island and visits to the various places of interest on its shores, as well as those inland. It was published in London by Sampson Low, and was highly commended by all the leading London journals. Later it was published in New York by Messrs. Harper Brothers.

The first complete collection of marine botany of Mauritius was made by Colonel Pike and forwarded to Professor Dickie, of Aberdeen, and that eminent savant's report was published in the Transactions of the Linnean Society, of London. He collected some thousands of fish of the Indian Ocean. His list with a report was published in the Royal Society Transactions of Mauritius. Four hundred or more of them he has painted from life. This is the first time a series of paintings on so large a scale has been attempted of the fish of the Indian Ocean. Most of his collections found their way in alcohol with other valuable contributions to the Museum of Comparative Zoology, Cambridge, Mass. Among the fish, when classified, there were found twenty-seven new species and two new genera. So valuable were these donations considered, they elicited the following testimony to their worth:

Boston, Mass., October 25, 1871.

To the Hon. Nicolas Pike.

Sir: I have the pleasure to inform you that at a meeting of the trustees of the Museum of Comparative Zoology held this day it was, on motion of Mr. Louis Agassiz, unanimously voted that the thanks of the board of trustees be tendered to the Hon. Nicolas Pike, United States Consul at Port Louis, for many invoices of the most valuable and well preserved specimens of natural history from Mauritius and the dependencies sent by him to our institution, which not only constitutes important additions to our collections, but are at the same time in themselves most valuable additions to our knowledge of the fauna of that part of the world. In devoting himself to these researches Mr. Pike has won an enviable place among naturalists, who will ever gratefully acknowledge his skill in hunting up and preserving specimens which at all times have taxed the ingenuity of explorers. I remain, sir,

Respectfully yours,
MARTIN BRIMMER,
Secretary.

In 1871 he was appointed by Sir Henry Barclay, governor of Mauritius, one of the commissioners for the collection and arrangement of the products of Mauritius to be exhibited at the Vienna Universal Exhibition to be held in 1872.

In 1871 he received a medal from the Royal Society of Arts and Sciences for valuable contributions at various times, together with drawings of new and rare specimens of natural history.

In 1891 Colonel Pike was elected a member of the Royal Society of Arts and Sciences, of London, England.

Colonel Pike is now advanced in years, but as active as many young men, and pursues his studies in the field with as much vigor and pleasure as he did forty years ago. His name is familiar to the readers of the SCIENTIFIC AMERICAN, to which he has contributed many most interesting and valuable articles.

DR. JOSE EVARISTO URIBURU, PRESIDENT OF THE ARGENTINE REPUBLIC.

BY the resignation of Dr. Peña, the former president, the duties of that high office are imposed upon the vice president, Dr. Uriburu, whose administration promises to be highly advantageous to his country. Dr. Uriburu has filled a number of important public positions, such as minister of justice, minister plenipotentiary and other offices connected with the diplomatic department of the government. On all occasions he has manifested the possession of high abilities and unswerving patriotism.

For our portrait we are indebted to La Ilustracion Sud-Americana.

THE SERVICES OF NATHANIEL BOWDITCH TO AMERICAN ASTRONOMY.*

By T. J. J. SEE.

THE series of articles on the study of physical astronomy may be appropriately continued by historical sketches of the careers of some of the great mathematical astronomers who established the scientific reputation of the United States, and laid the foundation of whatever is excellent in the history of American mathematics. Of the several great pioneers in the science of this country, probably no other has rendered a service so illustrious and enduring as that of Dr. Nathaniel Bowditch, the celebrated translator and commentator on Laplace's Mecanique Celeste, who may justly be regarded as the founder of American mathematics and of American physical astronomy. Moreover, the great excellence of Dr. Bowditch's character and his sacrifices in behalf of American science furnish an inspiring example of the highest type of scientific life, which ought to be better known and more appreciated in our time. We therefore gladly avail ourselves of an opportunity of rendering a pious tribute to this veritable disciple of Newton, whose memory is worthy of every veneration.

In endeavoring to point out how Bowditch attained such great scientific eminence in the earliest years of the republic, we shall rely for our information on the classic memoir, appended to the fourth volume of the translation, by his son Nathaniel Ingersoll Bowditch, which gives a just and appropriate account of the life and work of one of the greatest and truest of American philosophers.

Nathaniel Bowditch was born at Salem, Massachusetts, March 26, 1773, the fourth of the seven children of Hubakkuk Bowditch, whose ancestors had lived in Salem from the earliest times. The family of Bowditch had preserved a long and honorable history, but had always remained in humble circumstances; the members of it were connected in various ways with the shipping business of Salem, as merchants, coopers and ship masters. Dr. Bowditch's mother died in 1783, when he was but ten years old, but her exemplary character had already exercised a great influence on the development of his youthful mind; and it is thought that the early and pious instruction of this affectionate mother laid the foundations of that inflexible integrity of character by which he was so distinguished throughout life. His father met with business reverses at the beginning of the revolutionary war and never retrieved his fortunes, but remained in very reduced circumstances till his death in 1798. The family was thus brought up with very scanty opportunities; and the boys were early assigned to various trades as a means of livelihood. The brothers and sisters of Dr. Bowditch died at comparatively early ages, so that he outlived them all by nearly thirty years. Dr. Bowditch early displayed his unusual mental aptitude, and when at school mastered the most difficult problems with great rapidity. At the age of ten years he was taken from school into his father's cooper's shop, and two years later became an apprentice in a ship chandlery shop in Salem.

He continued in this employment until he sailed on his first voyage in 1795; when not engaged in serving customers, he spent his time studying mathematics, for which he had very decided taste. In 1787 Dr. Bowditch heard from his brother William, who afterward perished on a voyage at Trinidad, a vague account of a method of working out problems by letters instead of figures: and on securing the book was so much interested and excited by his first acquaintance with algebra that he did not get the least sleep during the whole of the next night. His studies at this period were quite varied, and were further broadened by the liberality of Dr. Prince and Dr. Bently, the Unitarian clergymen of Salem, who placed their libraries at his disposal.

The extensive scientific library of Dr. Richard Kirwan was captured in the British Channel by a privateer fitted out in Beverly, the town next to Salem, and when this valuable collection, containing among other precious memoirs the Transactions of the Royal Society, came to be the nucleus of the Salem Atheneum, the books were of course accessible to our author, who made a manuscript copy of most of the mathematical papers, partly because he could not afford to purchase the works, and partly because he wished to impress their contents more thoroughly upon his mind than could be done by a mere perusal.

In 1790 Dr. Bowditch began the study of Latin, in order to read the Principia of Newton, a copy of which had been presented to him by Dr. Bently. He labored over the great masterpiece with care, and wrote many notes on the language which contained the propositions announced by Newton; it is said that he had mastered the immortal Principia at the age of twenty-one years. Though Dr. Bowditch had steadily labored under extreme difficulties, owing to his poverty, it is said that he never regarded the obstacles in his path as in any way a hindrance to his advancement, but rather that they stimulated his efforts and rendered his progress more sure and steady. Bowditch's life led him to the conviction that it is a great disadvantage to be born and educated in the midst of luxury and ease; and he is said to have frequently mentioned with approbation the remark of a distinguished French mathematician (Lagrange) to a young student in whom he had become interested but who had told him of his parentage and situation in life: "Ah! I am sorry. You are too rich. You must give up mathematics."

According to the traditions of his ancestors, Dr. Bowditch began his career as a sailor boy at sea; he made four long voyages between 1795 and 1804, during which he visited the island of Bourbon, Lisbon, Madeira, Manila, Cadiz, Batavia, Sumatra, etc. Bowditch was always eager to teach those who desired to learn, and on the fourth voyage taught the crew how to take observations for determining the position of the ship at sea; when the captain arrived safely at Manila, after encountering a perilous monsoon, he was asked how he contrived to find his way, to which he replied "that he had a crew of twelve men, every one of whom could take and work a lunar observation as well, for all practical purposes, as Sir Isaac Newton himself, were he alive."

During these voyages Bowditch found much time for the study of mathematics and for perfecting himself in the French and Spanish languages. "He loved study himself," says Captain Prince, "and he loved to see others study. He was always fond of teaching others. He would do anything if one would show a disposition to learn. Hence all was harmony on board; all had a zeal for study; all were ambitious to learn."

Dr. Bowditch's great excellence of character deserves especial commemoration; a companion of his voyages says: "He never manifested any moral failings whatever, but was always remarkable for his strict principles of conduct, and for the utmost purity of mind and character, detesting anything of an opposite nature even in word. His feelings, indeed, were quick, and sometimes, though rarely, he was thought to give a quick utterance to them, but the excitement passed off in a moment." Another says: "I have known Dr. Bowditch intimately for more than fifty years, and I know no faults. This may seem strange, for most of your great men, when you look at them closely, have something to bring them down; he had nothing. I suppose all Europe would not have tempted him to swerve a hair's breadth from what he thought right."

In his early years Dr. Bowditch was given much encouragement to pursue his scientific career by Harvard University; in July, 1802, to his great surprise, he was given the honorary degree of master of arts. During the latter years of his life he was one of the seven individuals intrusted with the immediate management and control of the college; on his decease his associates in the corporation of Harvard College state "that he so acquired the confidence of his contemporaries, as to be regarded as the pillar and the pride of every society of which he was an active member, the effect of which never failed to be seen and acknowledged by its prosperity and success," and that Harvard College "has derived great benefit from the extraordinary endowments he possessed and by which, in the exercise of his characteristic zeal, intelligence, and faithfulness, he ever sustained and advanced all of its interests."

Dr. Bowditch was admitted to the American Academy of Arts and Sciences in 1799; and from his pen came many valuable papers which enriched its Transactions. In 1829 he was elected president of the Academy in succession to the illustrious John Quincy Adams, ex-President of the United States—a high honor which he continued to hold until his death, when his associates recorded of their late president: "It is the common fate of mankind to die and be forgotten. It is the privilege of the just and good to be associated in the remembrance with tender and grateful recollections. It is the destiny of minds gifted above the common lot, and acting beyond the common sphere, to involve in general regret the communities that have known their worth. It is thus that on the present occasion, our sincere and general regret is necessarily mingled with the sadness of domestic affliction."

Dr. Bowditch was twice married, on the first occasion, in 1798, to Elizabeth Boardman, who died a few months later while her husband was at sea; on the second occasion, in 1800, to Mary, the only daughter of Jonathan Ingersoll, which is regarded as the most happy circumstance of Dr. Bowditch's life. Undoubtedly many of his great achievements in later years and the comfort and satisfaction requisite for such intellectual efforts were directly traceable to the warmth and ideal beauty of his home life; so great was his appreciation of Mrs. Bowditch's steadfast devotion and care for the family that he dedicated to her memory his immortal translation of the Mecanique Celeste. The descendants of this great man have since retained a very high and honorable place in the history of Massachusetts, and several of them have been or are now professors in Harvard University.

The most celebrated work published by Dr. Bowditch in the early part of his career was the New American Practical Navigator. Though he did not regard this work as anything more than a "practical manual" which could hardly be expected to advance his scientific reputation, it came into universal use among English and American sailors, and has well retained its place to the present time. It was by the Navigator that Bowditch first became widely known in this country, and the popularity of our author among seamen may be gathered from the fact that on his decease flags floated at half mast in the harbors of Baltimore, Salem and Boston, and at Cron-

* From Popular Astronomy.

stadt, when the sad intelligence reached the capital of the Czars.

At the close of Dr. Bowditch's seafaring life, he was elected president of the Essex Fire and Marine Company, a position which he retained until he moved to Boston in 1823. During his residence at Salem he published numerous valuable papers in the Transactions of the Academy of Arts and Sciences. Some of these papers bear on navigation, others relate to the orbits of comets, eclipses of the sun, meteors, heights of mountains, variation of the magnetic needle; motion of the pendulum, solar tables, oblateness of the earth, mistakes in the Principia and Mecanique Celeste, etc. Besides these papers he published others in Zach's Correspondence Astronomique, the North American Review and other journals of the highest standing. The article on the progress of modern astronomy in the North American Review for April, 1825, is especially important to the critical student, and should in no case be overlooked. It consists of a sound and impartial historical criticism of the work of the great mathematicians who had preceded Bowditch, and each of the great masters here given the exact credit to which he is entitled.

We now come to speak of Dr. Bowditch's last and greatest work, the celebrated Translation and Commentary on Laplace's Mecanique Celeste. This work has undoubtedly had the greatest influence on the development of American astronomy, since the proverbial difficulty of the Mecanique Celeste renders it almost inaccessible to beginners; and in our universities and colleges astronomy has never been given that thorough and systematic attention which is merited by the dignity and inherent importance of the subject. Our universities have too often labored under the impression that the number of students in a given department is a just criterion of the importance of its educational work; the tendency has been to make the advancement of human knowledge subsidiary to numbers and majorities, just as if a multitude counted for anything in the discovery of scientific truth! It ought to be perfectly obvious that the development of a single man like Bowditch is of more importance in the advancement of science than perhaps all the other students in the college combined. As an example of this idea, we may cite the case of Gauss. His lectures at Gottingen were attended by very few students, his largest class in nearly fifty years numbering only thirteen, and yet by his works Gauss has become and will remain the teacher of all civilized countries during all succeeding ages. Laplace was professor of mathematics and astronomy at Paris, and yet only the least part of his influence was exercised during his lifetime. So also with Bowditch; he realized the importance of his work in time to come. Nearly all of our leading astronomers have been students of this great man, and the same is true of many of the astronomers of other countries.

DOCTOR DON JOSE EVARISTO URIBURU, PRESIDENT OF THE ARGENTINE REPUBLIC.

Dr. Bowditch had read the successive volumes of the Mecanique Celeste as they appeared, and by the year 1817 had completed the translation and commentary on the first four volumes. The fifth volume, which Laplace did not publish until 1825, was never translated, owing to Dr. Bowditch's death, March 16, 1838; but as the last volume of Laplace relates chiefly to the history of celestial mechanics, to the earth's temperature and the velocity of sound, Bowditch's translation is nearly complete so far as the strictly astronomical matter is concerned. The notes were revised and brought up to date as the work came to the press in 1829, 1832, 1834 and 1839. Benjamin Peirce assisted in reading and correcting the proof, and he thus became the logical successor of Bowditch, who had early discovered his extraordinary talents. Our author's object in translating the Mecanique Celeste was to supply the steps which Laplace had omitted, and which rendered the original work inaccessible except to the most learned mathematicians. The Edinburgh Review in 1808 said: "We will venture to say that the number of those in this island who can read that work with any tolerable facility is small indeed. If we reckon two or three in London and the military schools in its vicinity, the same number at each of the English universities, and perhaps four in Scotland, we shall hardly exceed a dozen; and yet we are fully persuaded that our reckoning is beyond the truth." It is said that not one person in America besides Dr. Bowditch had read the work critically, and not more than three would have been able to do so. The necessity of a translation and commentary was therefore obvious, and accordingly when the work appeared it was hailed with delight by astronomers in all the countries of the world. Dr. Bowditch was accustomed to remark that "Whenever I meet in Laplace with the words 'Thus it plainly appears' (il est facile de voir), I am sure that hours and perhaps days of hard study will alone enable me to discover how it plainly appears." Mr. Babbage in 1832 wrote to the translator: "It is a proud circumstance for America that she has preceded her parent country in such an undertaking; and we in England must be content that our language is made the vehicle of the sublimest portion of human knowledge, and be grateful to you for rendering it more accessible."

A second object of the translator was to continue the original work to the time of publication, so as to include the labors of those mathematicians who had improved upon some of the methods used by Laplace. Lacroix wrote in 1836: "I am more and more astonished at your continued perseverance in a task so laborious and extensive. I perceive that you do not confine yourself to the mere text of your author and to the elucidations which it requires; but you subjoin the parallel passages and subsequent remarks of those geometers who have treated of the same subject; so that your work will embrace the actual state of the science at the time of its publication."

Legendre, in 1832, writes: "Your work is not merely a translation with a commentary. I regard it as a new edition, augmented and improved, and such a one as might have come from the hands of the author himself if he had consulted his true interests, that is, if he had been solicitously studious of being clear." Bessel, in 1836, says: "Through your labors on the Mechanism of the Heavens, Laplace's work is brought down to our own time, as you add to it the studies of geometricians since its first appearance. You yourself enrich the science by your own additions, for which especial obligations are due you." Sir John Herschel, in 1830, wrote: "It is very gratifying to me to commence a scientific intercourse, which I have long desired, with the congratulations which the accomplishment of so great a work naturally calls for; and I trust that its reception by the public will be such (of which, indeed, there can be little doubt) as to encourage you to proceed to the publication of the succeeding volumes, and that you will be favored with health, strength and leisure to enable you to complete the whole of this gigantic task in the masterly manner in which you have commenced it. It is a work, indeed, of which your nation may well be proud, as demonstrating that the spirit of energy and enterprise which forms the distinguishing feature of its character is carried into the regions of science; and every expectation of future success may be justified from such beginnings." Encke, in 1836, writes of it as a work "which, by the depth of the researches with which it is accompanied, will insure to you a distinguished place among the astronomers who have employed themselves on the difficult branch of physical astronomy."

It will be seen from what we have said that Dr. Bowditch was moved only by the highest and most exalted motives, and this nobility of character and self-sacrifice appears perhaps still more clearly in the matter of the publication of this great work. The American Academy had generously offered to publish the work at their own expense, and the translator was also solicited to publish it by subscription; but these flattering offers were unhesitatingly declined, as Dr. Bowditch was aware from the nature of the subject that his readers would necessarily be few, and he did not desire to sell any one a book which he could not read. The publication was therefore delayed for a number of years, and finally completed from 1829 to 1839, at his own expense of over ten thousand dollars, which was one-third of the value of his entire estate. It is interesting and gratifying to know that in the recent edition of the works of Laplace, issued under the auspices of the Paris Academy of Sciences, some errors which Bowditch pointed out are corrected in foot notes, and in several cases the editors, MM. Puiseux and Tisserand, close their remarks with "Voir l'edition de Bowditch:" they also refer to our author as "le consciencieux commentateur."

But though Dr. Bowditch's chief work was not published till toward the end of his life, his fame as a mathematician and astronomer had become fully established, and the high honors of science were showered upon him. He was elected a member of the Royal Society of Edinburgh in 1818; Royal Society of London in 1818; Royal Irish Academy in 1819; Royal Astronomical Society of London in 1832; Royal Academy of Palermo in 1835; Royal Academy of Berlin in 1836. He was equally honored in his own country by being chosen to membership in all the learned societies of the time, and in 1816, at the annual commencement of Harvard College, he received the honorary degree of doctor of laws. In 1806 Dr. Bowditch was elected Hollis Professor of Mathematics in Harvard University, but this position was declined owing to an unwillingness to break up his long connection with Salem. In 1818 he was offered a similar position in the University of Virginia by President Jefferson, who said in making the offer: "We are satisfied we can get from no country a professor of higher qualifications than yourself for our mathematical department." In 1820 Mr. Calhoun, the Secretary of War, desired to nominate Dr. Bowditch to the vacancy in the chair of mathematics at West Point, and said in his letter: "I am anxious to avail myself of the first mathematical talents and acquirements to fill the vacancy." In 1823 Dr. Bowditch accepted the position of actuary to a life insurance company in Boston, and from the income thus derived (which amounted to $5,000 a year) eventually found the means of publishing the translation and commentary. When Bowditch left Salem, a banquet was given by his fellow townsmen "to their respected guest, who reflected upon his country the brightest honors of science, and diffused in social life the warmest influences of benevolence." The wish was expressed that "he might enjoy a happiness as pure as his fame and constant as the activity of his virtues," and it was declared that, "as the monarchy of France had done honor to her Laplace, so would the republic of America not be ungrateful to her Bowditch."

During the latter years of his life Dr. Bowditch took much part in developing and extending the usefulness of the Boston Atheneum. The trustees, on his decease, passed appropriate resolutions on his services to that institution and add: "But Dr. Bowditch has far higher claims to notice; he stood at the head of the scientific men of this country, and no man has contributed more to his country's reputation. His fame is of the most durable kind, resting on the union of the highest genius with the most practical talents and the application of both to the good of his fellow men. Every American ship crosses the ocean more safely for his labors and the most eminent mathematicians of Europe have acknowledged him their equal in the highest walks of their science. His last great work ranks with the noblest productions of our age." "But it is not merely the benefactor of this institution, and the illustrious mathematician, whose labors have given safety to commerce and reputation to his country, whom we lament. It is one whose whole life was directed to good ends; who combined the greatest energy with the kindliest feelings; who was the friend of every good man and every good undertaking; the enemy of oppression, the patron of merit, the warm hearted champion of truth and vir-

tue," etc. In like manner the Salem Marine Society declared that "In his death a public, a national, a human benefactor has departed. Not this community, nor this country only, but the whole world, has reason to do honor to his memory. When the voice of Eulogy shall be still, when the tear of Sorrow shall cease to flow, no monument will be needed to keep alive his memory among men; but as long as ships shall sail, the needle point to the north, and the stars go through their wonted courses in the heavens, the name of Dr. Bowditch will be revered as of one who helped his fellowmen in a time of need, who was and is a guide to them over the pathless ocean, and of one who forwarded the great interests of mankind."

The reader will now be able to judge of the merits and virtues of the illustrious dead, whose glorious example ought to be of incomparable service in the advancement of American science. It is much to be regretted that the classic memoir by his son, from which we have drawn the foregoing material, is not available in pamphlet form. His influence on the scientific progress of this country during the last fifty years has been great beyond all computation, and wholly free from the spirit of self-seeking which is so characteristic of some of the smaller and more degenerate minds of our day. His favorite student was Benjamin Peirce, whose labors have shaped the development of American mathematics and of American physical astronomy.

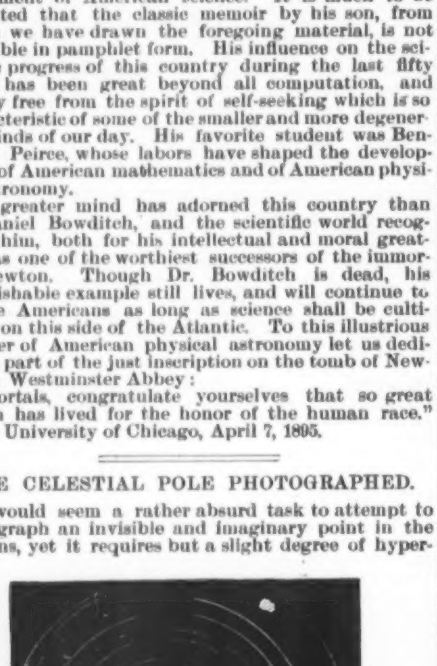
No greater mind has adorned this country than Nathaniel Bowditch, and the scientific world recognizes him, both for his intellectual and moral greatness, as one of the worthiest successors of the immortal Newton. Though Dr. Bowditch is dead, his imperishable example still lives, and will continue to inspire Americans as long as science shall be cultivated on this side of the Atlantic. To this illustrious founder of American physical astronomy let us dedicate a part of the just inscription on the tomb of Newton in Westminster Abbey:

"Mortals, congratulate yourselves that so great a man has lived for the honor of the human race."

The University of Chicago, April 7, 1895.

THE CELESTIAL POLE PHOTOGRAPHED.

IT would seem a rather absurd task to attempt to photograph an invisible and imaginary point in the heavens, yet it requires but a slight degree of hyperbole to assert that this has been done successfully by M. Camille Flammarion, the eminent French astronomer. He has contributed to Cosmos, Paris, March 16, an account of what he has accomplished, and we will let him speak for himself—in translation, of course:



PHOTOGRAPH OF THE ROTATION OF THE STARS ABOUT THE POLE.

"The perpetually changing position of the celestial pole amid the stars, due to divers movements of the earth, of which the principal is that of the precession of the equinoxes, can be determined with great precision by pointing a photographic apparatus toward the pole and letting the stars trace, by their movement around this point, their paths on the plate intended to register the motion.

"As long ago as the winter of 1869–70 I made a first trial to determine the position of the pole by observation of the movement of circumpolar stars. The pole was then situated nearly in the middle of a line drawn between two stars of the seventh magnitude, near the North Star. It was marked by the rotation of three little stars forming an elongated triangle and representing in some sort the last constellation that turns about the pole.

"By reason of the relatively rapid displacement of this point on the celestial sphere it is interesting to determine periodically the precise position of the prolongation of the earth's axis. The skillful constructor Fleury-Hermagis having expressed a willingness to put at the disposition of the observatory of Juvisy an excellent six foot photographic objective, and the Messrs. Lumine having offered plates of a remarkable sensibility, we chose, during the past autumn, the clearest moonless nights to direct the apparatus toward the pole, keeping it immovable, to receive on the plate the circular traces of all the neighboring stars. The experiment succeeded admirably. The times of exposure were 2, 4, and 6 hours. We see on the plates the circular traces in arcs of 30°, 60°, and 90°, of a considerable number of stars of all magnitudes, the size of the trace depending on the photogenic state of the star and the speed of its movement, which is less as we approach the pole. The plates were 18 by 24 centimeters [about 6 by 8 inches], covering more than 12 by 16° and bearing the traces of more than 200 stars.

"The harmonious image of the tranquil movement of the earth shows itself on these photographs as in a celestial reflection furnished by the stars themselves. It has been endeavored to reproduce by photogravure the plate whose exposure was four hours. This reproduction does not include the palest stars of the photograph, but it gives the most brilliant and furnishes an idea of the circular paths. The figure has been not reduced, but trimmed off. It contains one hundred circumpolar stars, that may be identified on the catalogues, notably that of Carrington.

"The photograph was taken on the 6th of September last, and the exposure lasted 250 minutes, from 7:50 P. M. till midnight. The arcs of the paths thus measure 60·5°. The image shown here is direct, that is, as one sees it in looking at the heavens with the naked eye. The stars are turning in the direction opposed to that of the hands of a watch."—Literary Digest.

THE VINES.

(VITIS.)

By W. J. BEAN.

THERE is, perhaps, no feature in the adornment of our gardens and woodlands where the gardener's art can be more effectively displayed than in the use of climbing shrubs. There is a peculiar charm about these plants which no other class possesses to the same degree. It is due to their surpassing grace, and to some extent also, no doubt, to the strong suggestion they give of the luxuriance that more especially belongs to the vegetation of warmer, sunnier lands than ours. Our indebtedness is shown in this, as in every other branch of ornamental gardening, to the floras of other countries, and in the beautiful genus with which in this paper I have to deal there is not a single species that is a native of Great Britain or even of Europe. The grapevines and the Ampelopsis (now included under Vitis) are, in regard to hardy species, represented most strongly in North America and Northern Asia, to a less degree only in Asia Minor. Except in the case of the hop-leaved vine hereafter mentioned, it is not for the beauty of the fruit that the wild types of Vitus are grown in these islands. It is their luxuriant habit, surpassing grace and wealth of handsome foliage, which in several instances affords the richest of autumnal colors—yellows, purples and crimsons—that constitute their great value.

Some thirty species are at present in cultivation that can be grown out of doors in the southern parts of this country, a very small proportion, of course, of the total number of species known, most of which are semi or purely tropical. They are all of climbing or rambling habit, and their variety in foliage and different degrees of vigor in growth enable one or other of them to be employed for almost every purpose to which climbers may be put. While some are especially valuable for the walls of houses, others may be used for covering arbors, pergolas, the pillars of verandas, old tree stumps or sloping banks. In the case of the stronger, taller growing species they may be made to clamber over living trees. Little need be said on the matter of cultivation. They are moisture-loving plants, and require liberal treatment at the root. Where space is limited they can be kept at any required size by means of pruning, but the most luxuriant effects are, of course, obtained where they can ramble without let or hindrance. Where they are intended to spread over living trees, they should always be planted sufficiently far away from the trunk to allow rain and light to reach them. Success, too, will be better assured by giving them a pocket of good rich soil to start in.

In the majority of the species increase can be accomplished by means of cuttings or by single "eyes," treated like those of the common grapevine. Some, however, are very obdurate and can only be increased by means of seeds. Layering will occasionally prove successful with those that refuse to root from cuttings. Grafting should only be resorted to as a last resource.

In the following enumeration of species the nomenclature adopted is that of the recently published "List of Hardy Trees and Shrubs" at Kew. The generic titles of Ampelopsis and Cissus are therefore sunk under Vitis.

NORTH AMERICAN.

V. Æstivalis	V. Quinquefolia (Ampelopsis)
Arborea	Q. var. Incisa
Arizonica	Q. var. Hirsuta
Berlandieri	Q. var. Muralis
Californica	Riparia
Candicans	R. var. Palmata
Champini	Rupestris
Cinerea	Striata (Cissus)
Cordifolia	Vulpina
Labrusca	

ASIATIC.

V. Aconitæfolia	V. Inconstans (Amp. Veitchi)
Amurensis	Japonica
Capreolata (Cissus)	Orientalis
Coignetiæ	Romaneti
Ficifolia	Serianæfolia (Ampelopsis)
Flexuosa	Thunbergi
Heterophylla	Vinifera
H. var. Humulifolia	V. var. Laciniosa
H. var. Variegata	Spinovitis Davidi
Himalayana (Ampelopsis)	

AMERICAN SPECIES.

V. Æstivalis (Summer Grape).—This species is probably the oldest of North American grapevines cultivated in England, having been introduced in 1656. It is described as abounding in wastes and woodlands. The leaves are broadly cordate, more or less deeply three to five lobed, being of a deep green color when old, but in a young state covered on the lower surface with a reddish down. They measure from 4 to 6 inches across, the marginal teeth being broad and shallow. The berries are small—about the size of black currants—but have been improved by cultivation. The larger leaved forms of this variable species are sometimes mistaken for V. Labrusca, but a ready distinction is afforded in the arrangement of the tendrils. In V. Æstivalis the tendril is missing from every third joint, but in V. Labrusca there is (with rare exceptions) a tendril or fruit stalk at every joint.

V. Californica.—This is, so far as my experience goes, the best of the American grapevines (i. e., excluding the Ampelopsis) for coloring in autumn. It is one of the strongest growers, climbing in its native home over lofty trees. Its leaves, which turn a deep crimson in autumn, especially after a summer like that of 1893, are rounded and covered with down.

V. Cordifolia (frost or winter grape). — A strong, vigorous growing plant with thin, three lobed, cordate leaves, measuring 3 inches to 6 inches in diameter, the lobes ending in a long, fine point, the coarse teeth being also sharply pointed. The berries are black and only palatable after they have been subjected to frost; hence the common name of frost grape. A moisture-loving vine, affecting in a wilde state the banks of streams. It has the same arrangement of the tendrils alluded to in V. Æstivalis.

V. Riparia is a near ally to the preceding, and by some authorities is reduced to a variety of it. The leaves are larger than those of V. Cordifolia (although the plant itself is smaller), smooth and shining, with long pointed teeth. The sweet, mignonette-like perfume of the flowers of many American vines is in this species especially apparent. The variety Palmata (V. Palmata, Vahl.) has the branchlets and frequently the petioles of a red color. It was cultivated in the Jardin des Plantes at Paris well back into the last century, and is conjectured to have been sent to France by the French missionaries, who were among the earliest plant collectors in the Mississippi region.

V. Labrusca (Northern fox grape).—Before the introduction of V. Coignetiæ this was perhaps the most striking and effective of the true grapevines in cultivation in Britain. Its leaves are among the largest, both they and the young branchlets being covered on the under surface with a rusty colored or sometimes whitish down. They are of stout texture and vary considerably in shape, sometimes entire, sometimes deeply lobed. There is almost invariably a tendril or a fruit stalk opposite each leaf, constituting the distinction between this and the four species previously mentioned, which has already been referred to. In a wild state the fruit has a musky flavor, but by cultivation it has been much improved, and numerous varieties of the species are grown in the United States.

VITIS HETEROPHYLLA HUMULIFOLIA.

Englemann says that, although not large as a rule, it occasionally reaches the top of high trees. In England it proves to be a strong grower and deserves a high place among ornamental climbers.

V. Vulpina (Southern fox grape).—A very distinct and handsome species, differing from the American species already enumerated in its close bark, which does not peel off. The leaves are small (2 inches to 3 inches across) and rounded, usually smooth and shining on both surfaces, and although coarsely toothed, rarely distinctly lobed. The species is worthy of note, as its small, bright green leaves may be used as an effective contrast with those of the Labrusca and Coignetiæ types, or may prove suitable in situations to which the larger-leaved species would not be adapted. Other American grapevines worth growing, but possessing no particular value beyond those already described, are V. Rupestris, Arizonica and Cinerea (the downy grape), all of which are in the Kew collection.

V. Quinquefolia. — This, the far-famed Virginian creeper, is better known as Ampelopsis Quinquefolia, or as A. Hederacea. Introduced, according to Loudon, in 1629, it has during the long period of its cultivation in this country become almost as well known as any of our native climbers. So far as autumn color is concerned, it is the finest of the American vines, its foliage changing in the fall of the year to various shades of crimson, scarlet and purple. The leaves consist of five (occasionally one or two less) leaflets, which are broadly lanceolate, with a few coarse teeth on the terminal half. For covering arbors, walls, verandas or old tree stumps there is no climber which produces so luxuriant an effect in so short a time as the Virginian creeper does. The following varieties are in cultivation: Major, Incisa, Hirsuta. Their distinctive characters are indicated by the names. Deserving of more detailed mention is Ampelopsis Muralis, a name current in this country and on the Continent, while the same plant is known in America as Vitis Englemanni. It is a distinct form of the Virgin-

ian creeper, possessing the same shaped leaves and developing equally, or even more, brilliant autumnal colors. Unlike the ordinary form, however, which requires support if it is intended to cover a wall, this is self-supporting, and will attach itself as firmly to any suitable surface as V. Inconstans does.

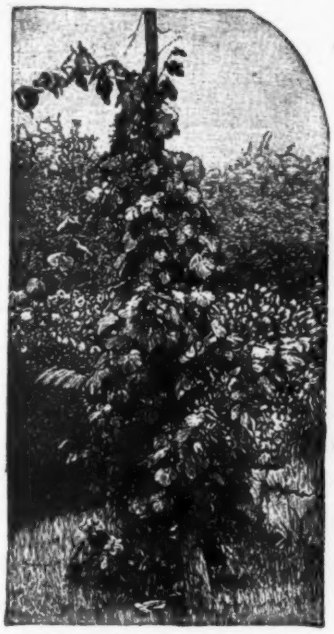
V. Arborea (Ampelopsis bipinnata).—A species of considerable beauty of foliage, differing from any other North American species here mentioned in having bipinnate leaves. The numerous leaflets constituting a single leaf are small and deeply toothed. It is not a quick grower in this country, and is naturally of a shorter and more bushy growth than is characteristic of the vines generally. Introduced from the Southern United States in 1700.

ASIATIC SPECIES.

Vitis Coignetiæ.—So far as this country is concerned, this is the newest and in some respects the most beautiful of all the vines. It is a native of Northern Japan, its nearest ally under cultivation being the North American V. Labrusca. For many years a vine clambering over a tall pine in Mr. Anthony Waterer's nursery at Knap Hill has been at once a puzzle and a delight to all who have seen it. The foliage before falling turns a glorious crimson, making one of the most beautiful of autumn garden pictures. Up to within the last year or so, however, its identity could never be ascertained, no specimens in herbaria or in living collections exactly matching it. There is now every reason to believe that it is Vitis Coignetiæ, of which numerous plants have been lately raised in this country from seeds collected in Japan. The under surface of the leaf is covered with a woolly down, which in Mr. Waterer's specimen is reddish brown; the color, however, varies; in some instances it is nearly white, but similar variations are met with in other species. The species is named in honor of Mme. Coignet, who gathered the seeds in the mountains of Northern Japan, and sent them to France in 1875. Seeds were again introduced to that country in 1884, but until recently very few plants appear to have reached England. We may now hope that in a few years' time it will constitute one of the most striking features of our gardens in autumn. The leaves are cordate, irregularly toothed, and measure each from 6 inches to 10 inches across. In size of leaf and vigor of growth it is at least the equal of any other vine in cultivation. It has hitherto proved difficult to propagate by the usual methods of eyes and cuttings, and with only very limited success when layered. It can be grafted on several of the American species, but in view of its superior vigor that is not likely to be a satisfactory method, and now that it is well known there is no likelihood of a dearth of seeds sent direct from Japan.

V. Heterophylla (also grown as V. brevipedunculata).—The hop-leaved vine, which is the variety of V. heterophylla known as humulifolia, is the most generally grown and most beautiful of the various forms of this species. Unlike any of the species hitherto mentioned, it has, besides its handsome foliage, the additional recommendation of producing in autumn a profusion of pretty turquoise blue berries. The leaves are smaller than in the common heterophylla and are usually more deeply lobed. This vine requires in most places a position on a wall in order to induce it to fruit with proper freedom, and appears to succeed better where it is restricted for root room. It was originally discovered by Dr. Bunge in North China, but has since been found in Japan and Corea. A variegated form of V. heterophylla is very pretty, the foliage being mottled with white or faint pink. A sheltered, sunny position is necessary to develop the variegation to its full extent.

V. Inconstans (syns., Ampelopsis Veitchi and A. tricuspidata).—The unfamiliar name here given is the one that properly belongs to the plant so well known as Ampelopsis Veitchi. It is the most beautiful of all the species in the Ampelopsis section of the genus, and for covering walls has no rival. As is the case with so many of the vines, this shows great variety in the shape of the leaves. In young plants the leaves



CLARET COLORED VINE.

are small and very often scarcely lobed at all, while in older ones they are cut into three lobes and occasionally into the same number of separate, short stalked leaflets. This tendency to variation shows itself also in the colors the leaves put on in autumn. In the best forms the foliage assumes various rich tints of purplish red and crimson; whereas others have a large admixture of brown in the coloring. There is also a form whose foliage has a bronzy hue more or less throughout the season, but especially when young. This climber is planted abundantly in Oxford, and more than once have I been charmed in autumn by the glorious masses of rich color on some of the walls and gateways of the college quadrangles. It is a plant of the very easiest propagation by means of cuttings. A native of Japan and introduced about 1868.

V. Romaneti is a species of recent introduction, and one which promises to prove very distinct and vigorous in habit. It has large leaves, of much the same size and shape as those of V. Coignetiæ, but it differs from all the vines in cultivation (except Spinovitis Davidi) in having the branches and petioles covered with bristles or stout hairs. It was discovered by the Abbe David in the Shen-si province of China.

Spinovitis Davidi is nearly allied to V. Romaneti, having the same bristly or even prickly character. Carriere says, however, that seedlings raised in France exhibit much variation in this matter, the bark of some being perfectly smooth. In any case the character is not one of sufficient importance to justify the creation of another generic name. In the Kew list of trees and shrubs it is referred (under a query) to V. vinifera. It was found by the Abbe David in the Shen-si province. Both this and V. Romaneti assume purplish red autumn tints.

V. Vinifera.—Of the numerous varieties of the common grapevine the following may be alluded to: Purpurea.—This is one of the deepest purple-foliaged plants we possess. Although the color becomes most intense in autumn, the leaves have a bronzy purple tinge from the first. It is not so quick a grower as the ordinary form. Var. lasciniosa or apiifolia is the parsley-leaved vine. Its leaves are very deeply cut, frequently into several leaflets, which are again deeply lobed. Besides these there are the Miller's grape, with smallish leaves covered with white down, and the "Teinturier" grape, the leaves of which assume a beautiful claret color before they fall.

Brief mention may be made of the following Asiatic species: V. ficifolia, a distinct plant with small round lobed leaves like those of the fig; V. flexuosa, V. thunbergi, whose foliage turns red in autumn; and V. serianæfolia, an interesting species of the Ampelopsis group, with tuberous roots like a dahlia, and with palmate or bipinnate foliage. All these are natives of China and Japan. V. himalayana is a North Indian species with striking trifoliate leaves.—The Garden.

WILD GRAPE VINES IN THE UPPER SAN JOAQUIN VALLEY, CALIFORNIA.

[DENISON QUARTERLY.]

THE BOTANICAL DEPARTMENT AT HARVARD.

IN 1842 Asa Gray was chosen professor of botany at Harvard University. This date may well be taken as the beginning of the botanical department of Harvard. At that time he received $1,000 a year salary, a portion of the income from the endowment of the chair being added to the principal for a few years.

In addition to this small endowment, the botanic garden had an endowment of $20,000. Dr. Gray was no sooner located in his new position than he began to plan for a further improvement of the garden. Seeds and plants were obtained from all quarters of the globe. Much of this collecting was done by Dr. Gray himself, and the plants obtained from other sources were very largely paid for by exchanges of his own material. Evidences of his numerous botanical excursions can be seen on every hand, in the garden, in the herbarium, and especially in the library, as shown by his numerous works on botany. He seems to have been able to inspire the general public with an appreciation of his work, for generous gifts soon began to flow in. These gifts have continued to increase in number and size as the department has grown in strength.

A few words about Dr. Gray and his work may well begin the account of this department of Harvard University. Those who knew him best speak of him as a modest and genial man, a most inspiring teacher and indefatigable worker. He was alert in his movements, quick at repartee and fond of argument. His interest in church work was always great, and for many years he was a teacher in the Sabbath school. Although not radical, he was greatly stirred by the events of the civil war. His letters to Darwin at that time are among the most interesting of all his correspondence. He did more than any one else to introduce the laboratory method in botanical teaching. With him the study of nature meant contact with nature, and not what some one else had written about that contact. What Agassiz did for zoology, Gray did for botany; and science occupies a much higher position in popular estimation because of his labors.

A few years after Dr. Gray's coming to Harvard we find associated with him as assistants two young men who were destined to become leaders in the botanical world and carry on the work so well begun by their teacher. In 1873 Dr. Gray resigned his professorship of botany, and one of these assistants, George Lincoln Goodale, was appointed in his stead. The other, William Gibson Farlow, a few years later, after study abroad, returned to take charge of the work in cryptogamic botany. Until his death in 1888 Dr. Gray remained as curator of the herbarium, enlarging and developing this most important aid to botanical work.

The teaching force at present consists of Professors Goodale and Farlow, Assistant Professor Thaxter and two assistants. In addition, there are seven or eight of the graduate students who have charge of the laboratory work in the course in elementary botany. The equipment of the department is as follows: The herbarium of phanerogams is located in the building at the Botanic Garden. It contains two hundred thousand sheets and more. (No one knows how many more.)

A curator and two assistants are engaged upon the study of collections which are constantly being acquired. A professional collector is also in the service of the herbarium. About eight thousand specimens are yearly added to the collection.

The Botanic Garden consists of seven acres of ground tastefully laid out into beds. Many fine trees of the rarer species are distributed through the garden.

In the beds there are plants of 1,500 native species, 1,300 foreign species and 400 varieties. In the greenhouses there are under cultivation about 2,400 species and varieties. In the selection of these plants those species which best illustrate points in vegetable morphology and physiology are given the preference. The Arboretum is at Jamaica Plain, about seven miles from Cambridge. It covers about 230 acres. By an arrangement with the city of Boston this has been made a part of the metropolitan park system. Thus the care of the walks and drives, police protection and similar necessary sources of expenditure have been assumed by the city. The location is most admirable. Steep cliffs, gently sloping hillsides and fertile valleys furnish a natural location for the various species of trees and shrubs here grown. The plan is to cultivate every species of trees and shrubs which is capable of withstanding the severity of a New England winter. How well the director has succeeded is at-

tested by the fact that the Harvard Arboretum is universally recognized as the finest in the world.

The Botanical Museum consists of a collection of economic plants containing practically all the products used by man. There are altogether between seven and eight thousand of these useful plants represented by their products. Only a small portion of this large collection is on exhibition. A small portion still remain unarranged. The greater part is most carefully preserved and labeled so that it is possible to find at once any product used by man in any country of the civilized world. The portion of the museum which attracts the most visitors is the room containing the glass flowers. Although these have so often been described in our newspapers and scientific journals, a few words may not be amiss.

They are manufactured in Germany by a man and his son named Blaschka. These models are made almost entirely of glass. The color is very largely in the glass itself, although some is placed on after the flowers are made. Where possible the entire plant is reproduced life size, in other cases a branch or a leaf and the flower cluster. The beauty and accuracy of these models is almost beyond belief. It is difficult to distinguish between these models and living specimens, when they are placed side by side. In a photograph it cannot be done. The artists, for artists they certainly are, have been at work upon these models for five years and over. So rapidly do they work that already five hundred species are represented. Their present contract expires in about seven years.

Although so much has already been done, the plans for the future development of the Botanical Museum are laid on a broad scale. Many new lines of development have already been opened and others await only the means necessary for such work.

The laboratories in use are eight, in addition to certain private laboratories for instructors and museum assistants. The most serious objection that can be made to these is that all have either east or west light. Their arrangement is not the best. Otherwise they serve well the purpose for which they were intended.

The courses in botany are:

No. 1. A general course in the morphology, physiology and classification of phanerogams. Half course.

No. 2. A course in general morphology, beginning with the lowest forms. Half course.

No. 3. Histology and physiology. Full course.

No. 4. Cryptogamic botany. Half course.

No. 20, a. Research work in histology, physiology, economic botany, etc.

No. 20, b. Research work in cryptogamic botany.

No. 1 and No. 2 are courses for undergraduates and do not count for the degree of A.M.

No. 3 and No. 4 are for both graduates and undergraduates, and can be counted for the degree of A.M.

The research courses are those leading to the higher degrees.

In the first four courses two lectures and six hours' laboratory work per week are required. It usually requires more hours of laboratory work than is indicated.

In the research courses, the men spend as much time as they can, depending on whether they count them for one or more courses. The number of students in the different classes during 1893-94 was as follows:

Botany 1.—170.
" 2.—49.
" 3.—19.
" 4.—17.
" 20, a.—12.
" 20, b.—10.
Summer class.—23.

Thus it will be seen that the laboratory method is the one everywhere in use. The aim of all the instructors is to train the students to interpret correctly their observations and express their thoughts either in clear, terse sentences or by well labeled and accurate drawings. The close contact with the professors and assistants, the keen criticism and close questioning of these instructors, make such laboratory courses a more useful study. As a means of mental discipline, as a source of knowledge becoming more useful each year, and as a study leading us closer and closer to the just appreciation of Nature and her laws, botany thus taught is certainly worthy of the place now given it in our more progressive schools.

Harvard University. H. L. JONES, M.S.

THE ARCHÆOLOGICAL WORK OF PROF. MOORE IN FLORIDA.

PROF. C. B. MOORE, the noted archæologist of the Philadelphia Institute of Arts and Sciences, is now engaged with a force of fifty negroes in demolishing the largest Indian mound in Florida, if not in the United States. The mound in question is situated on the St. John's River, about twelve miles from Jacksonville, or midway between the city and the ocean. It rises from the water's edge eighty feet, and its summit is crowned and made picturesque by a giant oak, which sprang up centuries ago and has flourished and grown strong by reason of sustenance furnished by the corpses of countless Indians buried beneath. The mound at present is 600 feet in diameter at the base, or 1,800 feet in circumference. In spite of its gigantic size now, it is estimated that fully one-third has been worn away by the action of the river. Hundreds of years must have been required for this wearing away process, for the St. John's is a placid stream of such great breadth that no freshet ever raises the water sufficiently for it to go booming to the sea.

The mound is fringed with a tangled growth of oak, palmetto and cactus. Work was begun half way up, and then straight in and down, and has progressed so far as to mould the mound into the shape of an entrenched and moated citadel. Against this citadel Prof. Moore was discovered lying prone, with his eyes close to the huge sandbank, busy with a trowel probing into the mysteries of this aboriginal cemetery. Skulls, crossbones, lower jaws of all sizes, besides pieces of pottery, were scattered all about, for these were the chaff of the discoveries. The archæologist was after more valuable things—trinkets, weapons, ornaments, arms—anything that would throw light upon the customs of those who inhabited Florida before Columbus turned the prow of his ship to the west.

Amid these grewsome surroundings the half a hundred negroes were working and singing their quaint ditties. At nearly every stroke of the shovel a skull was turned up, from which the superstitious darkies drew back with a grunt of awe, for the negro of the South has a horror of anything pertaining to the cemetery. Yet these negroes were hard-working, which was soon explained, for the professor had adopted a system of rewards for the more valuable finds. Anything out of the ordinary was worth a cigar, and one old darky, who was the prize delver of the party, had his hat band fringed with the brown trophies.

As the correspondent looked on, a negro's shovel threw out a string of beads. The next man yelled out:

"Lewis got somethin'." The next man took up the refrain, and it circled the hill in an improvised song.

Finally Prof. Moore came sliding down the mound, and for two hours he talked to the correspondent about his experiences in exploring mounds. For a long time he has been interested in matters relating to the Indians, and for four years he has been actively engaged in delving into mounds. He has examined these relics of the aborigines from the Great Lakes to the Gulf. For six weeks he has been at work in Florida, and the explorations of the colossal mound he is now engaged upon will complete his labors in this State.

According to Prof. Moore, all the Indian mounds in Florida and in the other States of the Union are pre-Columbian. "I have examined thousands," he said, "and have not found a single one the base of which was not laid before Columbus set out on his voyage of discovery. I do not mean by this that all the mounds were completed before the arrival of Columbus on these shores, but I assert that all I have examined—and I have examined thousands—were begun before the foot of the white man ever pressed the soil. I know this, because in none of the mounds has any trinket been found, save near the top, which could have been traced to the handiwork of the white man.

"These mounds were built almost entirely for burial purposes, and my examination has revealed some curious funeral customs in vogue among the pre-Columbian inhabitants of America. The Indians did not put the corpses in the mound immediately following death. They would leave the bodies on platforms, where beasts of prey could not get at them, until the flesh had dropped from the bones, and then they would put the bones in the mound and cover them with earth. Sometimes it would be five or six years before interment would take place.

"The dead were buried in layers. The mound would be begun and stand for several years before an interment was made. When a sufficient number of skeletons had accumulated, they would be placed on the mound and dirt thrown over them. Sometimes many years would elapse before the first layer of skeletons was complete. When sufficient skeletons had been placed to cover the base of the mound, a second layer would be begun, and the process was continued until the mound was built to an apex. Frequently right on top of a mound I have found a single skeleton. Just beneath there would be two or three, and so on down, the number increasing until the base was reached. This mound is the largest I have ever examined, and I am confident that at its base will be found nearly 1,000 skeletons.

"In this mound, midway down, a curious discovery was made. We found the skeletons of twenty-four men, and by the side of each was a musket of Spanish make. This find proves that they were buried here after the coming of Columbus and the Spanish adventurers who followed him. Frequently in exploring the Florida mounds I have found muskets, and sometimes cutlasses, always of Spanish make and always near the top. Never below the middle has anything been found that was not of pre-Columbian origin. A peculiar feature about the muskets is that they all appear to be loaded, showing that the Florida Indians believed in the Happy Hunting Grounds just as did their brothers in the West.

"Even in death the Florida Indians carried out the idea of precedence that swayed them during life. The chiefs were always given the post of honor when placed in the mounds. They were placed in the center and the skeletons of the men were ranged about them. After all the men had been placed then came the women and children.

"Come with me and I will show you what I mean," and the professor led the way up the side of the mound. We reached the top just as the negroes had struck a layer of skeletons. On the outer edges were what were plainly the skeletons of women and children. Then came the warriors, and in the center of the men was a skeleton of larger size than the others.

"That fellow was a chief," said Prof. Moore. "How do I know? Why, look at these ornaments." Sure enough, about the neck of the skeleton was a string of beads from which dangled a miniature tomahawk made of some translucent stone, which gleamed brilliantly as it caught the rays of the sun. On each wrist was a similar tomahawk attached, bangle like, to a circlet of beads. By the right hand of the skeleton lay a stone tomahawk of larger size, the handle of it long since reduced to dust. By the head of this skeleton one single feather was found, which had defied the flight of time and remained to bear mute witness to the fact that it once adorned the head of a chief.

"Have you found any skeletons of giant size in Florida, professor?"

"Only four or five. As a rule the Florida skeletons are below the normal in stature. I would not say that the pre-Columbian inhabitants of the State were a race of dwarfs, but they were a small people. I have never, save in a few instances, found the skeleton of a man six feet tall, the average being under five feet. The largest skeletons I have found in Florida were unearthed in Lake County recently. Curiously enough, too, I found them in a very small mound. They were ranged near the base, and there were about twenty of them. Some were full six feet in height, and all were in a remarkable state of preservation. One of the corpses seems to have been subjected to a process of mummification, for the skin had shriveled to parchment and still held the bones together. The fingers of this skeleton were clasped about a hatchet wrought in copper, and about the grinning skull was a string of copper beads.

"A noticeable thing in regard to the jaws of these skeletons is the remarkable soundness of the teeth. Look at this. You will notice that there is not an unsound tooth in it. This condition of the teeth in this skull is a type of those in all skulls. I have examined thousands, and in all the teeth are sound. Once in a while you will find where a tooth has been drawn—an evidence that toothache was known to them as a rare disease, and that the offending molar was promptly removed.

"Probably the most remarkable thing in connection with the skeletons of the Indians of Florida is their anatomical difference from the structure of other races. Their shin bones are invariably flat, the result, perhaps, of their devotion to the chase and the consequent drawing of the hard muscles against the bone. Another curious thing is that in nearly all of these skeletons a perforation is found in the humerus near the elbow. When that was announced the theorists said that it would be found only in the male skeletons, and that it was there because of the constant use of the paddle, but it was found also in the females. Then the theorists said that it was because the women exercised their arms in the constant grinding of corn, but they have not yet explained why it is found in the left arm as well as in the right in some skeletons and not at all in others."

Rising from his place on the side of the mound, which was shelving away under the assaults of the negroes with their shovels, Prof. Moore led the way to the steamer Alligator, which he has chartered for his Florida trip, and proceeded to show some of the wonderful things he has taken out of the mounds in this State.

"The pre-Columbians were a thrifty people," he said; "look at this." And he exhibited a piece of pottery with a hole in it. "That is dead pottery. The Indians of those days believed that everything had a soul, and they also believed in metempsychosis, or the transmigration of souls. They thought that after death the soul of the man went from the living thing to another. For that reason no living thing was ever placed with a corpse, lest the journey of the soul to the happy hunting grounds should be delayed by an unnecessary transmigration. At first they were accustomed to place broken pottery with the dead, but pottery was hard to make, and so these thrifty Indians began to make 'fake' pottery especially for burial services; that is, pottery with a hole in it. They put the hole in it to let out the soul, thus making it uninhabitable for the soul of the man by whose side it was buried. My opinion is that they called it 'hand-me-down-dead pottery.'

"But more remarkable than the fake pottery is this" and he held up a small snake made of copper bent into graceful curves, which would have challenged the admiration of Hogarth. "I have found three of these. They all came from the mound in Lake County in which I found the corpse that had been subjected to a process of mummification.

"Probably this is the most wonderful find," he went on, as he exhibited a copper breastplate which he found in a mound at Mount Royal, on Lake George. The breastplate was about two feet square, and on it were placed concentric circles, seven on each side. In the center of the breastplate in bass-relief was a neatly executed bird. It was not a conventional bird, such as would be drawn nowadays, but still no one could mistake what it was intended for."

"But where did the copper come from?"

"Oh, it is all a product of North America. When these copper trinkets were first found, it was thought that the Indians had had trading connections with European nations, but analysis of the copper has exploded this theory. These copper trinkets have been proved to be wrought of Lake Superior metal. And this leads to the belief that aborigines were closely united by trade. In proof of this I find copper breastplates and beads in Florida, and in Wisconsin and Michigan I find sea shells and sharks' teeth. It is evident that the Indians had trade connections and that the shells were given by the Florida tribes in exchange for copper."—Correspondence St. Louis Globe-Democrat.

THE DISTRIBUTION OF THE BLOW GUN.

THE blow gun is one of the most remarkable savage devices in which compressed air is used as a motive force. Primarily, the blow gun is a simple tube of cane, smoothly cleared of the joint septums, through which light darts feathered with a tuft of down, or pieces of pith, are propelled by the breath.

The blow gun is used for killing birds and small mammals. Frequently the arrows are poisoned, rendering the light dart effective on larger game. The chief merit of the blow gun is its accuracy and the silence with which it may be employed.

The penetration of the blow gun dart is greater than would be imagined. At the distance of 50 feet I have driven a blunt dart one-quarter of an inch into a pine plank. It is stated that the range of the blow gun among some tribes is from 80 to 100 yards.

Apropos to Professor Mason's paper connecting the Eastern Asiatics with the Americans along a great natural migration line, the distribution of the blow gun may be interesting.

The blow gun is a tropical or sub-tropical device, and may be looked for in regions where bamboo or cane grows. Nevertheless these tubes are often made of hard wood, single or of two excavated pieces joined together, and frequently one tube is thrust inside of another to secure rigidity. The examination of many of these blow guns inspires a great respect for the ingenuity and mechanical skill of the workers.

The curious fact of distribution, however, is that the Malays and American aborigines alone use the blow gun. The Malay specimens of the blow gun existing in the National Museum are from the Dyaks of Borneo, the Javanese, the Kyans of Burma and the Johore people from the Malay peninsula. The literature also supplies other Malay localities.

The North American specimens are from the Chetimachas, of Louisiana, who frequently combine the tubes in series, forming a compound blow gun, and the Cherokees of the Carolinas. From Central America,

the Indians of Honduras and Costa Rica; from South America, several Amazon tribes from Ecuador east and from British Guiana employ the blow gun.—Walter Hough, in Science.

LAKE BASINS CREATED BY WIND EROSION.*

In various parts of the great plains lakelets are somewhat abundant. At the north some of them occupy hollows in the uneven surface of the drift; elsewhere they are imprisoned by the unequal heaping of sand in dunes.

Those of a third class are independent of drift and dunes, and their explanation is not so readily apparent. They are so shallow that one may wade across them in any direction. They have no outlets and no permanent inlets. Their catchment basins are small. Ordinarily their basins interrupt divides between stream valleys, and they often rest on the highest tables of their vicinity. They are not permanent, but appear and disappear as storm and drought alternately prevail. Some basins are ordinarily dry, holding water only for a few days or weeks after a thunder storm. The lakes of others are approximately perpetual, disappearing only after a succession of dry seasons.

During the summers of 1893 and 1894, I rode extensively through a district in the Arkansas basin where these lakes are somewhat abundant; in one rectangular tract containing less than 1,000 square miles twenty were noted. Various hypotheses as to their origin were considered, and at the end of the first season wind action was preferred, but less because its process was understood than because each other suggested hypothesis seemed barred by some insuperable obstacle. In the second season, however, some allied phenomena were observed which seemed to throw light on the subject and served to strengthen the hypothesis of wind action.

The rocks of the country include a sandstone and two limestones which constitute the crests of the uplands, but the greater part of the surface is occupied by shales. The shales sustain a scanty growth of grass, with here and there a shrub and, more rarely, a few bush-like junipers. Their grade profiles are in general the typical products of subaerial degradation, convex upward on the divides, and elsewhere gently concave. Interrupting these simple and familiar slopes there were found a few saucer shaped cavities whose clean, smooth surfaces suggested at once their windswept character. They are almost wholly devoid of vegetation, and the shale from which they are carved is directly exposed without the intervention of residual or overplaced material. Three of them occupy a hillside sloping westward, so that the prevalent wind blows up hill. A part of the material excavated from these is deposited at their upper edges, and in the case of the individual most closely examined, has accumulated to such depth as to constitute a raised rim, deflecting the general drainage of the slope so that it passes around the hollow. The hollow itself is drained through several channels intersecting its lower edge. Rain and wind thus seem to be contesting for the mastery, and should the wind ever so deepen the saucer that it can contain without overflow the rain which falls upon it, a permanent lake basin may result. In another instance a small saucer is hollowed from an eastward slope, and here a clump of junipers standing at the lower edge has, by checking the wind, so aided the deposition of the detritus that the rim has been raised higher then the interior of the hollow and a temporary pool is the result. In yet another instance the hollow is carved on a southerly slope, and so deeply that it would pond the rainfall were it not tapped by a strong drainage line traversing the general slope at its eastern edge.

In each case the normal slopes of the country are sharply interrupted by the features of the saucer, whose steep sides descend quickly to a relatively level bottom. The wind seems to have first swept out a few feet of disintegrated and residuary material, and then been checked by the firmness of the unweathered shale, in which it can work no faster than the rock is disintegrated by frost and kindred agencies.

In four of the five instances the rock attacked is a dark shale, which is naturally almost sterile, so that vegetation on its surface is exceptionally scanty unless it is coated by an overwash of other material. This relation suggests that the condition essential to the initiation of the excavation is the absence of vegetation. The function of vegetation as a defender of the soil against ravages of the wind is already familiar, and it is easy to understand that whenever a tract of land in an arid region is deprived by some accident of its vegetal covering, the wind may at once become an important factor in its sculpture, clearing away all disintegrated material and, if the tract is small, producing a hollow. If the hollow is so related to the slopes and drainage that it can gather water but will not be filled to overflowing, a permanent basin may result, for alternate flooding and drying will tend to keep the bottom of the hollow barren, so that whenever it is dry the wind can continue its work. I believe the lake basins in question to have been created in this way.

In their present condition it is evident that they are naturally subjected to antagonistic processes dependent on the wind. While they contain water they receive dust from every gale that sweeps across the country, and the sediment thus accumulated, which is of no inconsiderable amount, tends, of course, to fill and thus obliterate them. When they are dry the wind resumes its erosive action and their bottoms are degraded. Professor Chamberlin has suggested an organic agency which also must constitute an important factor. In a region where springs and streams are rare the lakes are much resorted to by herds which, wading into the water to drink, carry away a coating of mud upon their feet and legs. The greater part of this mud is lost before they return, so that in this accidental way the beds of the lakes are steadily excavated and their margins enlarged. Horses and cattle sometimes increase their load by lying down in the mud, and their predecessor, the buffalo, is said to have the same habit.

With the pools called buffalo wallows I have little personal acquaintance, and I am not prepared to say whether their basins are initiated by the wind or constitute an independent class with purely bovine origin.

G. K. GILBERT.

* Read to the Geological Society of America, December 27, 1894.

THE CAUSE OF THE MOVEMENT OF GLACIERS.

When some plausible falsity appears in the columns of a scientific paper or magazine, it seems to me almost a crime to allow it to pass unnoticed. It has taken long to collect the data, it has cost the toil, even the lives, of thousands of the world's greatest men to wrest from nature the hidden laws by which she works. The results of these centuries of life and labor should be regarded as a most precious inheritance of the race, and should be guarded with corresponding jealousy. It is the duty of every man to stamp with the brand "counterfeit" whatever is false or seems so to him. In the disputation which follows, the truth finally survives alone.

In a lengthy article with the above title, which appeared in this paper April 6, the following explanation of the cause of the motion of glaciers was given, and was doubtless accepted by many people as final and correct, because it was in the columns of a reputable scientific paper:

"The method may be thus described: The heat of the sun melts the ice on the surface of the glacier, and it contracts in bulk on becoming liquid, and flows downward by the aid of gravitation into the interstices between the ice crystals below. Here the water is no longer influenced by the sun's rays, and again becomes crystalline; but the crannies and corners into which it has found its way are not suitable to contain it in the form of crystals, and, therefore, in parting with its heat it employs that irresistible force due to crystallization to make the cavities larger. In other words, it pushes away the molecules surrounding it down the path of least resistance. But we must not forget that the molecules of water, on becoming recrystallized, part with latent heat. This heat is taken up by adjacent molecules of ice, which, in their turn, become water, flow downward and exert pressure in the process of recrystallization. Thus, little by little, and from molecule to molecule, the heat derived from the sun is transmitted through the length and breadth of the glacier."

This is most certainly an original and striking theory of glacial motion; its only defect is that it lacks even one saving grain of truth. It would necessitate that glaciers have two methods of locomotion, one for summer and another for winter, which they should take on and put off as a man does his clothes. The foundation of this theory is the melting of the upper surface of the glacier by the sun; but glaciers move in winter, when the heat of the sun fails to melt any of this upper surface, thus making some other explanation necessary to account for their motion in winter.

The explanation given is inadequate to account for even the summer flow of glaciers. It assumes that the spaces between the molecules of ice are so great that they are readily entered by molecules of water under the influence of the slight force of their own gravitation. A block of ice is as impenetrable to liquids, and even to gases, under slight pressures as a similar block of iron. No special quality attaches to water formed by the melting of ice by the sun's rays. It is water, nothing more nor less, and will penetrate into the ice below it no more than will a pailful of water poured out on the ice of any pond. Given the layer of water on the surface, it could penetrate into the glacier only until it met the solid ice. Even granting the possibility that this thin layer of water could penetrate into the inter-molecular spaces of the ice below, the alleged action still remains an impossibility. That a molecule of water, by its mere contact with a molecule of ice, should itself change to ice and by its latent heat melt the adjacent molecule of ice, is as much a contradiction of the great law which rules the universe—the law of the conservation of energy—as if water should, of its own accord and without the influence of any external force, run up a hill for the sake of running down again.

Assuming that this second impossibility has taken place, there is another anomaly to be explained, viz., why "the path of least resistance" should be downward. Consider the water layer as having penetrated a couple of inches beneath the surface of the ice, with 500 feet of solid ice below. Provided the temperature falls and the walls in which the water particles are inclosed can be made to yield slightly, they will become solid. Conceive that they are now solidifying and expanding. Will the path of least resistance be downward, rending asunder the hundreds of feet of ice below, or will it be upward through the inch or two of ice above? Let common sense answer! Have you ever examined the ice in a stout iron kettle that has frozen solid? Ice forms not only on the surface and sides, but on the bottom also. As a result of this action, there is soon a quantity of water in the center, inclosed on all sides by ice. When this freezes it exerts its powerful thrust equally in all directions. The yielding is along the path of least resistance, and a hummock is formed in the middle of the dish, and this lump of ice is often cracked apart to the depth of several inches.

According to this theory, a man sprinkling the surface with a hand hose should be a more efficient agent for the locomotion of glaciers than the sun, for he could produce the film of water on its surface far more quickly. In spite of the glibness with which this theory of glacier motion is set forth, and the alluring sound of its phrases, "irresistible force due to crystallization," "path of least resistance," "latent heat," etc., the world will be compelled to fall back upon the time-honored theories of viscosity and of regelation, so beautifully set forth by Tyndall in his "Forms of Water."

O. P. WATTS.

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It requires skilled labor to turn out a billiard ball. One-half of it is first turned. Then the half-turned ball is hung up in a net, and is allowed to remain there for a year to dry. Then the second half is turned, and then comes the polishing. Whiting and water and a good deal of rubbing are requisite for this. It is necessary, in the end, that the ball shall, to the veriest fraction of a grain, be of a certain weight.

WAVES AND VIBRATIONS.

Lord Rayleigh recently delivered a lecture on the above subject at the Royal Institution, and said that he would show a variation of Savart's experiment in which a jet of falling water regularizes itself. He took a bung, A, Fig. 1, carrying the wooden rod, A H, to which the metal plate, Y, was attached at the bottom. Through the tube, K, a short piece of glass tube pass-

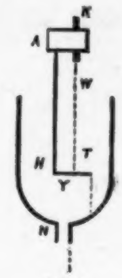


FIG. 1

ed, conveying a thin stream of water, which broke into drops at W, and the drops fell on the plate, Y, causing vibrations in the wooden rod and the tube, K, thus setting up periodic motions in the falling stream, and causing it to regulate itself, so that the fall of the drops gave a musical note. N is an inverted glass gas jar, acting as a resonator. When he put his finger at T, to intercept the drops before they reached the metal plate, the regularizing and the musical note ceased, and nothing was heard but the splashing water. He said that when the spacing between the drops is long in comparison with the diameter of the jet the equilibrium is more stable, and entered into the philosophy of the phenomena of jets of falling water, as revealed by Savart, Plateau, and others. In the case of a viscous thread, such as one of treacle or half molten glass, the thread does not resolve itself into drops or beads in the same manner, but presents to the physicist an entirely different mathematical problem.

In another of his experiments on falling water drops, the board, A, Fig. 2, carried a glass tube, N, through which a fine thread of water, W H, was forced up, and

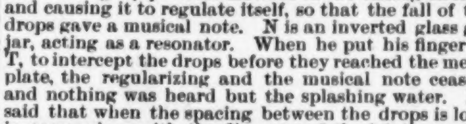


FIG. 2

broke into drops at H, which drops fell into a vessel placed to catch them below, T. Under normal circumstances the thread of water broke into several lines of drops but when periodic vibrations were imposed upon the jet by placing a sounding tuning fork, K, upon the board, A, the drops collected into a single line from H, until they nearly reached the vessel, T. He then spoke of jets of water of different kinds, and told how Mr. Chichester Bell ten years ago used very fine jets in researches on the subject, and showed that if they were made to play upon a stretched membrane, the latter formed a sort of telephonic reservoir, and the sound was magnified.

If a tuning fork be excited by a bow the sound gradually dies down, but there are various ways of maintaining sound by drawing upon some source of energy by which the motion otherwise lost can be sustained. In the organ pipe, for instance, energy is supplied in the form of wind. The vibrations of a tuning fork can be electrically maintained as in one on the table before him, with an electro-magnet between its prongs. A dipper below the longer prong, and over a little cup of mercury, acted as a make-and-break commutator, to send pulsations of electricity to the electro-magnet, so that the vibrations were maintained by electrical force; in such arrangements it is necessary that the force shall not depend alone upon the position of the vibrating body, so the explanation is not so easy as it appears at first sight.

That hydrogen flames will set up and maintain singing noises in tubes was noticed soon after the discovery of that gas; these "singing flames" are not happily so named, for they do not correspond with the pipe of an organ, but with the bellows. He put a small hydrogen flame inside a large globular resonator, and thereby excited a very deep note, deeper than any note used in music, except perhaps in the organ. He also showed that the tube conveying the hydrogen plays a part in the production of the sound of singing flames, for when the little glass tube conveying the gas is adequately stopped with cotton, as by the insertion of a cylindrical lamp wick, although the gas passes and keeps up the flame, no musical note can then be obtained. He then described Trevelyan's rocker, which is heated and made to rest in the middle upon two ledges, upon a cold piece of metal below, and which then gives out a musical sound maintained by heat. He had a piece of large iron gas pipe into which a man could thrust his arm, and perhaps six feet long, hanging vertically from the lower end of a rope, the upper end of which was attached to the roof of the theater. About a foot up the pipe were four thicknesses of wire gauze, which he made very hot by means of a Bunsen's flame; when the flame was withdrawn, the heated gauze set up and maintained for a time a powerful solemn musical sound, by vibrations of the column of air in the pipe; this experiment originated with a Dutch physicist named Rita.

Lord Rayleigh exhibited a revolving mirror which kept absolute time with a vibrating electric tuning fork. The driving power was a little piece of electro-magnetic apparatus governed by the vibrating fork. He said that the velocity of the mirror was not nearly so great as that with which Foucault determined the velocity of light, but from its accuracy it was useful for various physical purposes.

THE COLLAPSE OF SAINT CATHERINE'S TUNNEL.

To the long list of accidents and damage caused by the severe frost of February must be added the very serious and inconvenient one, happening on the London and Southwestern Railway, near Guildford, early on the morning of March 23 last, when the partial collapse of Saint Catherine's Tunnel buried a train of (fortunately) empty carriages, and completely blocked the Portsmouth line.

The Engineer, London, says: The Southwestern Railway, immediately below Guildford, is carried through some short tunnels leading from the hilly district of the North Downs to the low and level lands by Shalford and Godalming, through which runs the river Wey; and the last of these tunnels—360 yards in length—pierces Saint Catherine's Hill, which, unlike the chalky eminences all around, is composed entirely of the softest and most friable sand. This is the shorter of the two tunnels at the south of Guildford Junction, with which travelers on the Southwestern main line between London and Portsmouth are familiar. One long tunnel pierces the Hog's Back and terminates at Saint Catherine's, while the shorter tunnel runs under the hill of Saint Catherine's, on the crest of which are the remains of an ancient chapel. The tunnel is probably rather more than fifty years old, lined with red brick, six courses deep at the entrance. Immediately over the Guildford end were built the stables and coachhouses of a modern villa residence, and the house itself, as may be seen in our illustration, stands only just clear of the tunnel.

A train of empty carriages leaving Petersfield at 11:40 Friday night, and due at Guildford at 12:20 A. M., proceeded thus far with safety at about thirty miles per hour; but, almost on emerging from the Guildford end, was met by a huge heap of sand and earth, estimated at 1,000 tons, that had fallen through the crown of the arch, and carrying with it the coach buildings, four carriages and two horses, blocked most effectually any further progress. The engine driver and fireman fortunately escaped, though not without severe injuries, while the guard sustained a severe shaking. It is stated that the driver and stoker removed the fire or damped it down and then retired. Several of the carriages were smashed, and had they been otherwise than empty, it would not have been merely a tale of destroyed property that is read to-day. About an hour after the driver and stoker had left the engine, a further subsidence took place, and the engine and foremost carriages were completely embedded in the sand and debris. Only a quarter of an hour earlier a Southeastern passenger train from Charing Cross had passed under the tunnel.

As soon as the accident became known, Mr. Stredwick, the district superintendent of the permanent way, was on the spot, and a gang of about 100 navvies was set to work as soon as possible with a view to extemporizing arrangements to enable the traffic to be continued. The tunnel is completely blocked, and a fortnight will probably elapse before the traffic through it can be resumed. Passengers and luggage are conveyed by cabs between Guildford and Saint Catherine's. The distance is about one mile from Guildford Junction. London omnibuses and horses and drivers now provide a regular service. As much of the Portsmouth traffic as possible is being taken via Eastleigh. A temporary platform has been constructed near the tunnel, at the Saint Catherine's end. The scene of the accident was visited by thousands of people on Sunday and Monday.

At the Guildford end of the tunnel, shown in our engraving, all that could be seen on Monday is a great mass of yellow sand. Entering the other end of the tunnel, three carriages were visible. Two of these are smashed to pieces, one having telescoped itself into the other. The guard's van appears to be uninjured. "The Beacon," the residence of Dr. Wakefield, nearly over the tunnel, remains uninjured, but the large stable and coachhouse, with harness room and summer house, which were situated right over the tunnel, are entirely swallowed up; only two of the walls and the floor of the harness room were left at the edge of the chasm. Two horses were in the stables, and there were four carriages in the coachhouse. Not a trace of any of these is to be seen. The hole is almost circular.

The cause of the accident is held to be the bursting of a water main connected with the house above the tunnel, the water percolating through the brickwork and wetting and weighting the sand, so that the brickwork was weakened and the sand easily carried away when the first break commenced.

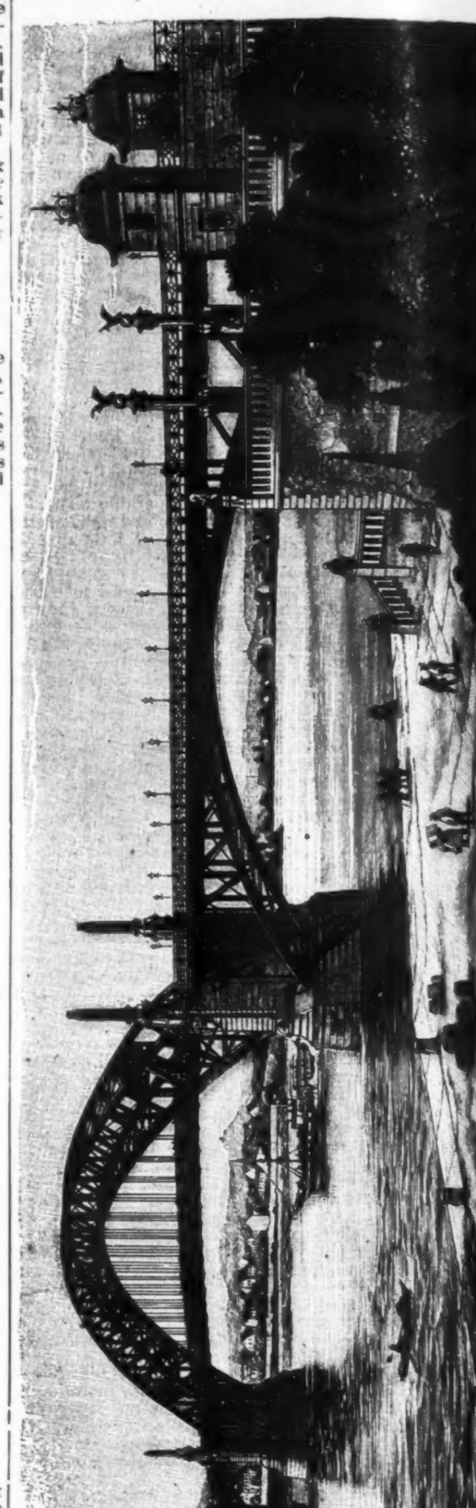
THE COLLAPSE OF SAINT CATHERINE'S TUNNEL.

PROPOSED BRIDGE ACROSS THE RHINE AT BONN.

It has long been evident that a bridge across the Rhine at Bonn was much needed, and on July 10, 1894, circulars were sent to the engineers of the world inviting them to send in designs for such a structure. Prizes of $1,900, $1,400, $900 and $700 respectively were offered for the four best plans, and competent judges were appointed to award these prizes. The designs were all sent in on December 31, 1894; they consisted of nearly four hundred sheets of drawings, including numerous artistic perspective views. The first prize was given to Prof. Krohn, director of the Gutehoffnungshütte at Oberhausen, who was assisted by R. Schneider, contractor, and Bruno Möhring, architect, of Berlin.

The specifications called for a waterway at least 492 ft. wide, and uninterrupted by any piers, where the river was deepest, and also required that the piers should be at least 196 ft. from each bank. It was difficult to meet the former requirement in a symmetrical design, as the deepest water is not in the middle of the river, but Prof. Krohn solved the problem by giving the central span considerably more than the length required. His design was so boldly conceived and presented such beautiful lines, at the same time fulfilling all technical requirements, that all other plans had to give way to it. He made the central span 656 ft. long and each of the side spans 360 ft. long. In order to give a correct idea of the great length of this central span, we will state that none of the spans of the longest arched bridges in the world—the bridge across the Mississippi, at St. Louis; that over the Douro, at Oporto; that across the North-Baltic Sea Canal, at Levensau, and the bridge at Müngsten—exceed 590 ft., while the central span in Prof. Krohn's design is, as we have stated, 656 ft. long. In the two side spans, the arches are low and flat, the proportion of the height to the length being as 1 to 11; while in the central arch the height is to the length as 1 to 6, the arch rising to a height 65 ft. above the roadway, which is suspended therefrom. By this arrangement of the central span and the elegant form of the piers, Prof. Krohn and Mr. Möhring have obtained a most beautiful bridge that is perfectly adapted to the situation.

It cannot be doubted that this fine design of Prof. Krohn will have a decided influence on the development of bridge building. When iron bridges were first made, the beauty of the structures was entirely overlooked in the effort to meet all requirements of strength and durability; then there was a time when attempts were made to render these structures, so unsightly in themselves, more pleasing to the eye by means of paltry ornamentation; but finally engineers learned to give beautiful lines to the structures, so that the modern iron bridge, as it stands out in silhouette, is very satisfactory.



PROPOSED BRIDGE ACROSS THE RHINE AT BONN.

For the accompanying engraving of Prof. Krohn's design we are indebted to our esteemed contemporary the Illustrirte Zeitung.

DISTILLATION APPARATUS FOR LABORATORIES.

IN a large number of chemical preparations, it is customary, in order to effect the separation or purification of certain volatile bodies properly, to proceed to fractional distillation. Although this method does not always suffice to effect a perfect separation of the various volatile elements mixed, we are, nevertheless, often obliged to have recourse to it for want of a better process. Chemists have, therefore, endeavored to give distillation apparatus the best arrangement possible to effect this object. It is a description of the latest improvements in this line that we desire now to present to our readers.

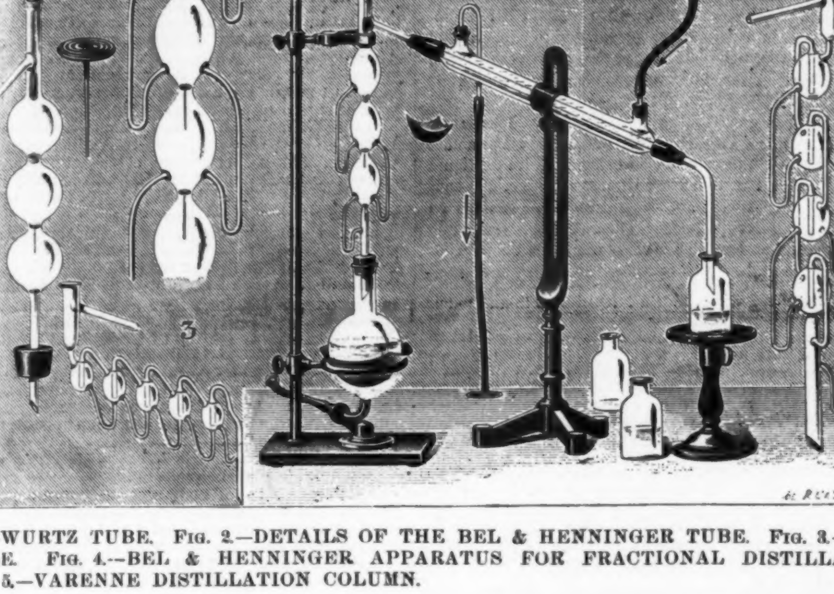


FIG. 1.—WURTZ TUBE. FIG. 2.—DETAILS OF THE BEL & HENNINGER TUBE. FIG. 3.—OTTO TUBE. FIG. 4.—BEL & HENNINGER APPARATUS FOR FRACTIONAL DISTILLATION. FIG. 5.—VARENNE DISTILLATION COLUMN.

The problem of fractional distillation is exceedingly complex. The more or less complete separation of the various elements depends upon a host of factors—the solubility or insolubility of liquids one in another, the tension of their vapors, the possible entrainement of one vapor by another that is more volatile, etc. All such considerations and all such difficulties sufficiently explain why it has been impossible up to the present, despite all tentatives, to solve the question of fractional distillation in a perfect manner.

Edward Adam, the inventor, who died in 1807, had already laid down the principles to be followed in order to obtain the best solution of this very important problem. The separation of the less volatile parts must be obtained (1) by a partial condensation of the vapors and (2) by methodical washings of the vapors in the liquids of condensation. This is the object that an attempt has been made to realize as well as possible in the apparatus that have since been devised.

Twenty years ago the Wurtz tube was used for fractional distillation. The vapor that rose from the boiling mixture to be split up was not condensed and collected directly, but was "analyzed" by cooling, so as to cause the less volatile portion to fall back into the generator and to cause only the vapor that had resisted condensation to enter the refrigeratory. To this effect, the Wurtz apparatus (Fig. 1) was composed of quite a large tube, in which two or three balls were blown, and which was provided with a lateral tube that ran to the refrigeratory. This tube was arranged, through the intermedium of a stopper provided with an aperture, upon the balloon containing the mixture to be split up. The less volatile part of the vapor produced condensed in the balls and fell back into the balloon, while the more volatile portion traversed the balls and flowed through the lateral tubulure into a refrigeratory at the extremity of which it was collected after its condensation. To the upper extremity of the Wurtz tube was adapted a thermometer that indicated the temperature of the vapor passing into the refrigeratory.

This apparatus did not realize the second condition necessary for obtaining a good result, i. e., the washing of the vapors in the liquids of condensation. It is just this inconvenience that an endeavor has been made to avoid in the arrangements subsequently devised. An imitation has been made, as perfect as possible, and upon a small scale, of the large industrial distillatory apparatus of Derosne & Cail, Dubrunfault, Savalle, and others.

To this effect, Messrs. Le Bel & Henninger have devised a special ball tube that bears their name. It is a tube formed of a series of balls separated by constrictions, in which is arranged a small basket of woven platinum or a platinum wire wound in a spiral and terminating in a tail (Fig. 2). The successive constrictions from top to bottom are smaller and smaller, so as to render it possible to introduce these platinum parts through the top. Moreover, from the upper part of each ball starts a tube bent into a siphon, which runs to the ball immediately beneath, and, finally, to the upper part is adapted a tubulure that runs to the refrigeratory. This apparatus, having been adapted to a balloon containing the liquid to be distilled, operates as follows:

The vapors that are disengaged become partially condensed in the balls and the liquids accumulate upon the platinum pieces. When the quantity condensed exceeds a certain limit, the siphon tube placed at the side becomes primed of itself and causes the excess of liquid to descend upon the lower plate. As every ball operates in this manner, it will be seen that during a normal operation the condensed liquids cannot accumulate upon any platinum plate and that the excess falls back constantly into the balloon. Therefore, with this apparatus, we obtain on the one hand a partial condensation of the vapors, and on another hand a washing of the vapors passing through the plates in the liquids of condensation that accumulate in each ball.

Le Bel & Henninger tubes of from one to five balls are to be found in commerce. It is the latter model that is the most used. If it is desired to effect a distillation with a larger number of balls, the apparatus are superposed by means of either ground glass or rubber joints, if the latter substance is not attackable by the liquid to be distilled. It is of interest to operate with as large a number of balls as possible, for the inventors have shown that the result obtained by these apparatus is an exponential function of the number of platinum pieces or plates.

About a year ago Mr. Otto devised an apparatus based upon the same principle (Fig. 3). It consists of a series of balls whose long axes are vertical, and which are placed in an ascending series, making an angle of about twenty degrees with the horizontal. The lower parts of two consecutive balls are united by siphon tubes designed to prevent too great an accumulation of liquid. The upper parts are connected by a bent tube, which extends to the bottom of the second ball and which is designed to lead the vapors and cause them to bubble through the liquids of condensation. The operation of this apparatus is analogous to that of the Le Bel & Henninger tube.

The ordinary models of the Otto tube are the five, six or seven ball ones. Several of these tubes may be connected by joints, if it is desired to have a large number of balls. In this case the apparatus is provided with a special support that renders the management of it more convenient.

Fig. 4 shows the application of the Le Bel & Henninger tube to fractional distillation.

Mr. Barillot has united the two tubes just studied into a rectifying apparatus, that consists of a Le Bel tube surmounted by an Otto one.

For neutral liquids, it is possible to make use of a metallic tube of the same model, thus avoiding the fragility inherent to the use of glass.

Last year, Mr. Eugene Varenne brought out a fractional distillation column, Fig. 5, formed of elements entirely separate from each other and communicating through two tubes, one of them leading the vapor and causing it to bubble through the liquid condensed in the ball, and the other carrying off the excess of such liquid condensed in the element immediately underneath. The manufacture of this glass apparatus is quite delicate, but Mr. Varenne has had a larger industrial metallic column constructed, exactly like the glass model, and which we shall describe further along. The fractional apparatus that we have thus far examined are applicable to cases only in which we have small quantities of liquid to distill. They cease to be practical when we have quite a large quantity of liquid, say twenty-five gallons, to operate upon, as may happen in the study of the products of certain fermentations, in researches upon and the separation of the carburets of petroleums, etc. It is of interest in such cases to employ a semi-industrial apparatus in order to avoid a loss of time.

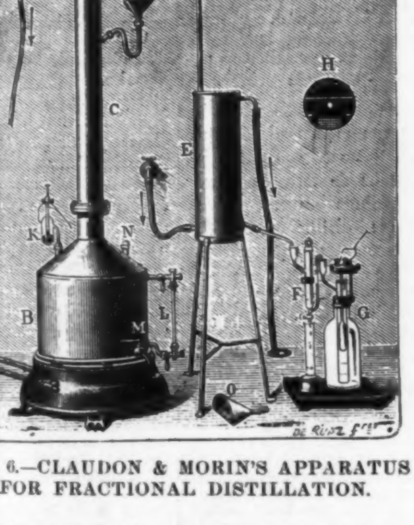
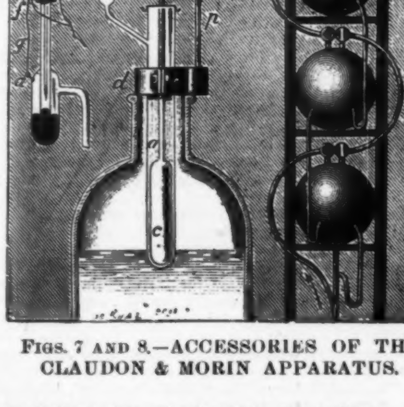


FIG. 6.—CLAUDON & MORIN'S APPARATUS FOR FRACTIONAL DISTILLATION.

A column of this kind has been constructed after plans by Messrs. E. Claudon and C. Morin. The apparatus is of copper with brazed joints, Fig. 6. It consists essentially of an iron plate gas furnace, of a boiler, B, of a column, C, of an analyzer, D, of a refrigeratory, E, and of various accessory apparatus.

The boiler, B, is capable of holding from 6 to 8 gallons of liquid. It is provided with a blow-off cock, M, a water level, L, an aperture, N, for filling, to which is adapted a copper funnel, and a stuffing box, K, for the pressure gage. The column, C, consists of a cylinder containing ten plates, the plan of one of which is seen at H. In the center of the column there is a circulatory tube that permits of varying the condensation according to the liquid that is to be operated upon. At the upper part of the column there is a thermometer that shows the temperature of the vapor passing at this place. The analyzer, D, retains the froth that is often produced at the beginning of distillations of fermented worts. It permits of the return of such froth to the column and perfects the fractional distillation. Finally, it carries a thermometer, which, being protected against superheating, gives more accurate readings than the column thermometer. The refrigeratory, E, is a simple worm around which circulates a current of cold water.



FIGS. 7 AND 8.—ACCESSORIES OF THE CLAUDON & MORIN APPARATUS.

The accessory apparatus comprise a gage, test glass and various alarms that may be connected with an electric bell in order to indicate the exact instant at which the presence of the operator is necessary. Fig. 7 gives the details of these apparatus.

In the pressure gage placed at K, in Fig. 6, and represented in Fig. 7, the copper piece, b, is traversed by a rod, c, that terminates in a platinum wire. It is fixed at the proper distance from the mercury by means of the set screw, d. The terminal, e, communicates with the piece, b, while the terminal, f, is isolated and is connected by a wire, g, with a platinum wire, a, that traverses the glass and communicates with the mercury of the apparatus. It will be at once seen that when the pressure increases to too great a degree, the level of the mercury, in rising, will establish a communication between the two platinum wires and thus set the electric alarm in action.

The gage, F, Fig. 6, permits of constantly observing the density of the condensed liquid and of taking specimens through the lower cock. The alarm placed at G, Fig. 6, is formed, as shown in Fig. 7, of a glass tube, a, having an aperture at the side and bottom. The distilled liquid passes from the gage test glass into the bottle through the funnel, b. This tube contains a float, c, of thin glass. An insulating piece, d, of wood or ebonite, fastened by bolts, e, carries a copper rod, p, upon which may be fixed a second piece by a set screw, b. When the flask is full, the extremity of the float causes a contact between two strips of platinum, r and m, that the terminals, i and k, put in communication with the electric alarm.

Mr. Varenne's industrial apparatus consists, in principle, of the same elements as that of Messrs. Claudon and Morin. The column alone differs from it by its special construction, which is identical with that of the glass ball tube that we have described. We give a diagram of it in Fig. 8.

Mr. Varenne's column presents the following advantage. If, during the distillation, one of the elements happens to be out of use for any reason whatever, it can be disconnected without arresting the apparatus. To this effect, it suffices to maneuver the three-way cocks that surmount each element. Consequently the cleaning and running of the apparatus are facilitated.

Such is the present state of the question of fractional distillation in laboratories.—La Nature.

TEA AND ITS EFFECTS.*

By JAMES WOOD, M.D., Visiting Physician to the Brooklyn Central Dispensary.

EXCESSIVE tea drinking is fast becoming a greater evil in this country than it ever has been in England and Ireland, the countries most noted for this indulgence. People so easily fall into the habit of using this form of stimulant that they are surprised when the physician calls their attention to the fact that they are drinking too freely. It is generally thought to be so harmless that it has become almost a household drink in many families, and in consequence the use is steadily increasing. It is, indeed, a very frequent occurrence to find one member of the profession advising patients to use tea and another immediately prohibiting its use. This procedure testifies most strongly to a want of some definite knowledge of the subject, and consequently there is no principle for guiding the course to be taken. What result this condition of affairs has had upon the limitation of the use of tea is well illustrated in the increasing demand and consumption in this country.

In 1890 there were imported into the United States 83,494,956 pounds of tea, an appreciable increase over the previous decade, and giving an allowance of 1⅓ pounds to each individual—truly a surprising quantity.

Some there are who deny that "theinism" is a common condition. In reply the statement is made that since January 1, 1894, of 1,000 patients applying for treatment, 100 gave such symptoms in the general examination as to point directly to tea inebriation. How many suffered from a similar condition, but applying for treatment for such diseases that did not necessitate going into a history of their daily customs, were addicted to the same habit, it is hard to state. The estimate is made that at least 50 per cent. drank the infusion to a greater or less extent. Here, then, we have clinical data of a cause of 10 per cent. of the ordinary derangements which one meets in general practice, especially in our large cities. Surely the importance of the question merits a careful study of tea and its effects upon the system.

There seems to be a very wide divergence in the results of different authorities in the analytic examination of the tea leaf or of an infusion of the same. Probably the best representative analysis is as follows:

Theine	2·8	per cent.†
Albuminoid principles	3·5	per cent.‡
Carbohydrate elements	9·0	per cent.§
Tannic acid	14·2	per cent.‖
Essential oil	0·75	per cent.
Cellulose	23·0	per cent.
Water	—	per cent.

These are considered the principal constituents of the tea leaf, but besides the ones already mentioned, we have others, such as wax, resin, extractives of different kinds, salts, xanthine, hypoxanthine, boheic acid, and apo-theine. From this extensive list of constituents we might with justice consider the tea leaf a very complex body. However, there are but few of value either from a dietetic or scientific standpoint. Those which we shall consider are theine, tannic acid, and the essential oil.

Tea is usually used in the form of an infusion—very often it is a pure decoction, made from the leaves, and the action which it has on the human organism is as the sum of the effects of the three important constituents named above. The theine affects directly the nervous system primarily and the organic system secondarily; the tannic acid affects the digestive apparatus and such organs as are intimately connected with it; while the essential oil gives us the peculiar intoxication so typical of tea dipsomania. The natural order of study of this commodity and the effects of its use would be to consider at this point the infusion of tea. Tea is usually taken in this form by the people at large. The length of time of the infusion will greatly change, not only its composition, but influence almost entirely its action upon the system imbibing the same. A good example of this is found in the following table of the difference in the amount of tannin taken up in a three and fifteen minute infusion:

	Finest Assam.	Finest China.	Common Congo.
Infusion for 3 minutes yielded	11·30 per cent.	6·77 per cent.	9·37 per cent.
Infusion for 15 minutes yielded	17·73 per cent.	7·97 per cent.	11·15 per cent.

It will be seen from this table that in an infusion of fifteen minutes of the finest Assam (Indian) tea, the yield of tannin is nearly two and a half times as much as the finest China. In all of the different teas, we find the length of time of the infusion affecting greatly the composition, with possibly an exception in the case of the better qualities of China tea. About six-sevenths of the entire soluble matter—33 per cent.¶—of the tea leaf can be incorporated in the first infusion. Again the authorities differ** greatly, but the above percentage will be found to be that most often met with in teas in common use in this country. Of the total amount of nitrogenous substances, 47 per cent.†† is soluble and is present in the infusion. The amount of tannin will range from 7 to 11 per cent., differing in the kind of tea. The amount of essential oil is about 0·75 per cent., and is present in larger quantities in the first infusion than in subsequent ones, and if the tea is not drunk immediately, it is soon lost. This is well illustrated in the frequent headaches complained of by professional tea tasters, who use the infusion immediately after it is made. Thus much for the constituents of the infusion.

The amount of tea which can be drunk every twenty-four hours with impunity differs with the individual. Some people are profoundly intoxicated by indulging in two cups of strong tea per day, while cases have come under my observation where fifteen pints of the strongest were taken every day with very little damaging effects. Usually we find that an ounce of tea leaves used daily will soon produce poisonous symptoms. This amount would contain from six to ten grains of thein.

The question might very properly be asked: What are the functions of the body disturbed by drinking tea, and what prominent symptoms are most often present?

From the first 100 cases which presented themselves for treatment and advice the following analysis has been prepared:

ANALYSIS OF SYMPTOMS IN 100 CASES OF THEINISM.

Sex: 69 per cent. female; 31 per cent. male. Quantity: 2 pints or less, 54 per cent.; 4 pints or less, 37 per cent.; 20 pints or less, 9 per cent. Strength: 77 per cent., strong; 15 per cent., ordinary; 8 per cent., not known. Number nervous: 72 per cent. Bowels: 40 per cent., constipation; 2 per cent., diarrhœa; 15 per cent., irregular. Pains: 16 per cent., general; 10 per cent., heart; 9 per cent., back; 6 per cent., side; 7 per cent., chest. Dizziness: 20 per cent.; faintness: 8 per cent.; gastric and intestinal indigestion: 19 per cent.; intestinal catarrh: 8 per cent.; dreams: 5 per cent.; "nightmare:" 5 per cent.; depression: 10 per cent.; despondent: 20 per cent.; excited: 5 per cent.; suicide: 3 per cent.; headache: 45 per cent.; rheumatism: 5 per cent.; irregular menses: 12 per cent.; palpitation: 19 per cent.; muscular tremor: 12 per cent.; insomnia: 15 per cent.; anæmia: 6 per cent.; dyspnœa: 5 per cent.

In subsequent cases careful study is being made of the irregular cardiac action, hallucinations, nightmares, successive dreams, obstinate neuralgia, anxiety, a persistent, sinking sensation in the epigastrium, prostration and general weakness, excitement, and mental depression. These are more or less present in nearly all cases of tea intoxication, and are often the symptoms for the relief of which the patient seeks medical advice. Certainly comment on the table is hardly necessary; it bears silent but impressive witness.

In the abuse of this drink we have the ætiological factor, either direct or indirect, for nearly 50 per cent. of the headaches, one-fifth of the cases of dizziness, and the same percentage of despondency and palpitation of the heart. Truly an agent capable of so strongly affecting the human organism is worthy of more than passing attention.

The effects of tea drinking on the digestive organs is very pronounced. In a large number of cases it is the active agent in the production of constipation, in others an alternating constipation and diarrhœa, and in some an intestinal catarrh. Some patients after drinking tea give a history of severe abdominal pains accompanied with nausea, and the action of the bowels greatly diminished.

These or any of the effects which tea has on the digestive system are largely due to the astringent action of the tannin.

Schwann has shown that tannin will throw down a precipitate from artificial digestive fluids and render them inert. What else can we expect but deranged digestive action, when people will indulge in copious draughts of strong tea before, during, and after each meal, and often nearly every hour in the day?

Let us now consider the principal constituents of the infusion of tea separately that we may better appreciate the latent power which they contain. The theine is probably the most important of them all, and yet what changes this nitrogenous body undergoes in the system is still uncertain. We know that the end products, like those found after the metamorphosis of any nitrogenous body, are undoubtedly urea, uric acid, creatinine, water, and carbonic acid, but what intermediate changes have occurred before the final results are reached is unknown. If it is oxidized artificially, we have as the result methylamine (CH_3H_2N), hydrocyanic acid (HCN), and amalic acid ($C_{12}H_{12}N_4O_7$).

Theine lessens the tissue metamorphosis to a considerable extent,* as we find a decrease in the amount of carbon dioxide expired. If theine is pushed until we get its full physiological effects, we have a general excitement of the circulation, with rapid pulse, muscular tremor, and a very urgent wish to empty the bladder. The imaginative faculties are more acute, or the mind may wander, hallucinations and visions make their appearance, and a peculiar form of intoxication supervenes. These symptoms end, after a long period of wakefulness, in a deep sleep from exhaustion. Theine seems to affect chiefly the sensory system, but in large doses, it may cause spasms and convulsions. The peculiar rhythmical contraction, which we find in the voluntary muscular fibers and lasting for a considerable period, often several hours, acts transversely across the fiber, because we find that it is elongated at each contraction. Hypodermatic injections of the theine acting on the sensory system produce local anæsthesia at the point where the needle was inserted, and for some distance below, thus having an efferent action along the nerve trunk. It is not narcotic.

Of the 47 per cent. of nitrogenous substances, little of value can be said. Traces of xanthine and hypoxanthine were found by Baginsky, and these bear the same relation to similar if not identical bodies which we find in the extract made from muscular tissue, and they undoubtedly occur as the result of a like process, namely, a retrograde metamorphosis of nitrogenous elements.

The amount of nitrogenous elements which is available for nutrition is manifestly too small to be of any value, and additionally it exerts little if any influence in the chemico-physiologic changes by virtue of which vital force is now produced. The arguments which certain individuals bring forth to substantiate its high sounding claim as a valuable addition to our list of food stuffs are truly amphigoric.

The next most important constituent of tea is the essential oil. This oil gives the aroma to the tea in a properly prepared infusion. Johnson is skeptical about its existence before the roasting and drying process has been completed, and thinks it is produced during this procedure. It is found more plentifully in the green tea, and seems to be lost during the greater oxidizing process through which the leaves are put in order to produce the black variety. Physiologically it exerts a stimulating and intoxicating effect which is so powerful that the natives do not use tea until it is at least a year old. This alone is the narcotic agent found in the tea leaf and infusion. The amount usually found will average about 1 per cent.

Mention has been made of a difference existing between the black and green varieties of tea. The green tea is richer than the black in theine, essential oil and tannin, and all the constituents soluble in water by fully five per cent. The influence which the green tea has on the nervous system, and for which it is largely noted, is due to one of the above named constituents—the essential oil. Among the better class of people who drink tea, and can afford the better varieties, the black is given the preference, because it is less astringent and exerts less influence on the nerves. The poorer classes, in Ireland especially, use the Indian (Assam) and cheaper varieties and cannot avoid the deleterious effects which the better class escape.

Next to the effects of tea on the nervous system, the digestive organs are most often deranged functionally. In so many cases the so-called infusion of tea is nothing more or less than a very strong decoction that its contact of secreting and excreting surfaces must result in harm. If tea is imbibed too soon after a meal is taken, the digestive action will be seriously disturbed and hindered. The condition is not to be wondered at when we are aware of the ease with which the active agents of the digestive juices are precipitated and rendered inert by the tannin, or tannic acid, always present in the infusion or decoction. A very persistent gastric disturbance is often excited and maintained, which is positively non-responsive to any medicinal remedy and is only relieved by a total abstinence from the use of tea. In a large percentage of tea inebriates, as can be seen from the analysis given, the action of the bowels is greatly diminished, nausea is common, and very distressing abdominal pains are present. The nerve ganglia of the solar plexus are in an irritable condition, and a sinking feeling in the epigastrium is much complained of.

This description of the effects of tea on the nervous system and digestive apparatus is necessarily brief. To elaborate the different effects noted in those who indulge too freely, would be to narrate most of the common complaints suffered by humanity. In reports just received from institutions for the insane in Ireland great prominence is given to the immoderate use of tea as a causative factor in insanity.

The use of tea by the two sexes is a very interesting study. In the table of the 100 cases reported, 69 females were inebriates, while only 31 were of the male sex. This difference is often greater, especially among the poorer classes in our cities. Why this difference between the sexes exists is probably explained by the greater use of tobacco by men and the consequent satisfaction for a stimulant. Women assuage the importunities of the system for a simulant by tea.

Undoubtedly the primal cause of the use of stimulants is poor health. Excessive labor, insufficient and unhygienic sleep, improper and inadequate amount of nutrition extending over a long period, possibly years, creates the best possible condition which calls for stimulants.

It is hardly within the province of this article to discuss the relation of tea drinking to poverty, general perverseness, and other economic factors; these are reserved for future narration.

The relative position of theine among other stimulants is interesting, as we may thereby the more readily appreciate the power which this drug—for we may with justice so class it—is capable of exerting.

Theine and digitalis exert certain physiological actions in common. In toxic doses reflex action is lowered, especially of the nasal mucous membrane, by exciting Setschenow's inhibitory center. Both cause prostration, muscular tremor, and often convulsions.

They are mildly diuretic and diminish urea and uric acid. They caure nausea, vertigo, and abdominal pains. They are antagonized by opium.

The contrast between theine and caffeine is of still greater interest, because a large amount of so-called caffeine is made from old tea leaves, and is nothing more than theine. Is it, then, to be wondered at that some of the caffeine found in our shops proves of so little value?

Attention is called to the following table of the comparative actions of the two drugs:

THEINE.	CAFFEINE.
Affects sensory system.	Motor.
Produces neuralgia.	Does not.
Causes spasms.	Does so late, if at all.
Causes convulsions.	Does so late, if at all.
Impairs or abolishes nasal reflex.	Does so late, if at all.
Diminishes temperature.	Increases.
Is astringent.	Is relaxing.
Dilates capillaries of splanchnic arcade.	Contracts the same.
Mildly diuretic.	Is powerfully so.
Causes irregular and feeble cardiac action.	Causes strong and regular.
Causes sinking sensation in epigastrium.	Relieves the same.
Causes sick headache.	Relieves the same.
Opposes active nutrition.	Increases nutrition and tone of system.

While theine and caffeine are diametrically opposite in the above actions on the system, they are similar in producing cerebral excitement, wakefulness, hallucinations, and a soporific state following the exhaustion of insomnia. It is very apparent from our study of tea and its principal constituents, that we have an agent of great power—one capable of producing the most detrimental effects on the system.

A fact has been noted among those tea inebriates who also drink coffee which is in support of the above statement. There are a considerable number of people who indulge very freely in both coffee and tea, and it is often difficult to determine which is producing the poisonous effects.

When we endeavor to make a diagnosis by exclusions aided by the table already given, the difficulty is even greater. Caffeine and theine do undoubtedly antagonize each other, or rather, the symptoms which each are likely to produce alone are not present when the two are used in conjunction with each other. This

* From the Quarterly Journal of Inebriety.

† Kozai says 3·3 per cent.; Muller, 0·65 per cent.; Peligot, 3 per cent.; Stenhouse, 2 per cent.; Bauer, 1·3 per cent.; Parkes, 1·8 per cent.

‡ Kozai says 5·9 per cent.; Muller, 3 per cent.; Bauer, 9·4 per cent.; Parkes, 2·6 per cent.

§ Parkes, 10 per cent.

‖ White, 7·17 per cent.; Parkes, 15 per cent.; Kozai, 10 per cent.

¶ Pavy, Bauer, and Peligot.

** Soc. of Pub. Analysts of Eng. says 30 per cent.; Muller, 45 per cent.; J. Lehman, 15 per cent.

†† Parkes.

* Dr. Edward Smith, Phil. Trans.

was first noticed in some few patients who could drink large quantities of both tea and coffee and be but slightly affected thereby. They, however, complained the most of insomnia and cerebral excitement and of almost no other symptom. The study of the action of these two drugs in the system at the same time was one of the most interesting phases of our investigation of tea intoxication and gave the idea for the employment of caffeine in the treatment of this condition—a procedure which has given the best results.

It is a question whether theine represents any physiological action worthy of a place as a therapeutic agent. It has been used hypodermatically in a few cases of sciatica, but with uncertain results. That its constant administration either in the uncombined form or in conjunction with other bodies, as for instance in the infusion or decoction of tea, is followed by undesirable effects on the system is undeniable. The pernicious influence on the organism which our study of tea has brought to light, and with its increasing use, should not be lightly treated, but an effort made to educate the people as to the danger of using it. Tea is one of the principal articles given to the poor by the charitable societies of some churches, and is a factor, therefore, of some importance in producing the increase of sickness among these unfortunates.

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SUMMARY OF CONCLUSIONS OF A REPORT BY DRS. D. H. BERGEY, S. WEIR MITCHELL AND J. S. BILLINGS UPON "THE COMPOSITION OF EXPIRED AIR AND ITS EFFECTS UPON ANIMAL LIFE."*

1. THE results obtained in this research indicate that in air expired by healthy mice, sparrows, rabbits, guinea pigs or men, there is no peculiar organic matter which is poisonous to the animals mentioned (excluding man), or which tends to produce in these animals any special form of disease. The injurious effects observed of such air appeared to be due entirely to the diminution of oxygen or the increase of carbonic acid, or to a combination of these two factors They also make it very improbable that the minute quantity of organic matter contained in the air expired from human lungs has any deleterious influence upon men who inhale it in crowded rooms, and hence it is probably unnecessary to take this factor into account in providing for the ventilation of such rooms.

2. In ordinary quiet respiration no bacteria, epithelial scales or particles of dead tissue are contained in the expired air. In the act of coughing or sneezing such organisms or particles may probably be thrown out.

3. The minute quantity of ammonia or of combined nitrogen or other oxidizable matters found in the condensed moisture of human breath appears to be largely due to products of the decomposition of organic matter which is constantly going on in the mouth and pharynx. This is shown by the effects of cleansing the mouth and teeth upon the amount of such matters in the condensed moisture of the breath, and also by the differences in this respect between the air exhaled through a tracheal fistula and that expired in the usual way.

4. The air in an inhabited room, such as the hospital ward in which experiments were made, is contaminated from many sources besides the expired air of the occupants, and the most important of these contaminations are in the form of minute particles or dusts. The experiments on the air of the hospital ward, and with the moisture condensed therefrom, show that the greater part of the ammonia in the air was connected with dust particles which could be removed by a filter. They also showed that in this dust there were micro-organisms, including some of the bacteria which produce inflammation and suppuration, and it is probable that these were the only really dangerous elements in this air.

5. The experiments in which animals were compelled to breathe air vitiated by the products of either their own respiration or by those of other animals, or were injected with fluid condensed from expired air, gave results contrary to those reported by Hammond, by Brown-Séquard and D'Arsonval, and by Merkel; but corresponding to those reported by Dastre and Loye, Russo Gilibert and Alessi, Hofmann Wellenhof, Rauer and other experimenters referred to in the preliminary historical sketch of this report, and make it improbable that there is any peculiar volatile poisonous matter in the air expired by healthy men and animals, other than carbonic acid. It must be borne in mind, however, that the results of such experiments upon animals as are referred to in this report may be applicable only in part to human beings. It does not necessarily follow that a man would not be injured by continuously living in an atmosphere containing 2 parts per 1,000 of carbonic acid and other products of respiration, of cutaneous excretion and of putrefactive decomposition of organic matters, because it is found that a mouse, a guinea pig or a rabbit seems to suffer no ill effects from living under such conditions for several days, weeks or months, but it does follow that the evidence which has heretofore been supposed to demonstrate the evil effects of bad ventilation upon human health should be carefully scrutinized.

6. The effects of reduction of oxygen and increase of carbonic acid, to a certain degree, appear to be the same in artificial mixtures of these gases as in air in which the change of proportion of these gases has been produced by respiration.

7. The effect of habit, which may enable an animal to live in an atmosphere in which by gradual change the proportion of oxygen has become so low and that of carbonic acid so high that a similar animal brought from fresh air into it dies almost instantly, has been observed before; but we are not aware that a continuance of this immunity, produced by habit, has been previously noted. The experiments reported in the appendix show that such an immunity may either exist normally or be produced in certain mice, but that these cases are very exceptional, and it is very desirable that a special research should be made to determine, if possible, the conditions upon which such a continuance of immunity depends.

* Results of an investigation made under the provisions of the Hodgkin's Fund. Read before the National Academy of Sciences, April 16, 1895, by permission of the secretary of the Smithsonian Institution.—Science.

8. An excessively high or low temperature has a decided effect upon the production of asphyxia by diminution of oxygen and increase of carbonic acid. At high temperatures the respiratory centers are affected when evaporation from the skin and mucous surfaces is checked by the air being saturated with moisture; at low temperatures the consumption of oxygen increases, and the demand for it becomes more urgent. So far as the acute effects of excessively foul air at high temperatures are concerned, such, for example, as appeared in the Black Hole of Calcutta, it is probable that they are due to substantially the same causes in man as in animals.

9. The proportion of increase of carbonic acid and of diminution of oxygen, which has been found to exist in badly ventilated churches, schools, theaters or barracks, is not sufficiently great to satisfactorily account for the great discomfort which these conditions produce in many persons; and there is no evidence to show that such an amount of change in the normal proportion of these gases has any influence on the increase of disease and death rates which statistical evidence has shown to exist among persons living in crowded and unventilated rooms. The report of the commissioners appointed to inquire into the regulations affecting the sanitary condition of the British army properly lays great stress upon the fact that in civilians at soldiers' ages in 24 large towns the death rate per 1,000 was 11·9, while in the foot guards it was 20·4, and in the infantry of the line 17·9; and shows that this difference was mainly due to diseases of the lungs occurring in soldiers in crowded and unventilated barracks. These observations have since been repeatedly confirmed by statistics derived from other armies, from prisons and from the death rates of persons engaged in different occupations, and in all cases tubercular disease of the lungs and pneumonia are the diseases which are most prevalent among persons living and working in unventilated rooms, unless such persons are of the Jewish race.

But consumption and pneumonia are caused by specific bacteria, which, for the most part, gain access to the air passages by adhering to particles of dust which are inhaled, and it is probable that the greater liability to these diseases of persons living in crowded and unventilated rooms is, to a large extent, due to the special liability of such rooms to become infected with the germs of these diseases. It is by no means demonstrated as yet that the only deleterious effect which the air of crowded barracks or tenement house rooms or of foul courts and narrow streets exerts upon the persons who breathe it is due to the greater number of pathogenic micro-organisms in such localities. It is possible that such impure atmospheres may affect the vitality and the bactericidal powers of the cells and fluids of the upper air passages with which they come in contact, and may thus predispose to infections the potential causes of which are almost everywhere present, and especially in the upper air passages and in the alimentary canal of even the healthiest persons; but of this we have as yet no scientific evidence. It is very desirable that researches should be made on this point.

10. The discomfort produced by crowded, ill-ventilated rooms in persons not accustomed to them is not due to the excess of carbonic acid, nor to bacteria, nor, in most cases, to dusts of any kind. The two great causes of such discomfort, though not the only ones, are excessive temperature and unpleasant odors. Such rooms as those referred to are generally overheated; the bodies of the occupants, and, at night, the usual means of illumination, contributing to this result.

The results of this investigation, taken in connection with the results of other recent researches summarized in this report, indicate that some of the theories upon which modern systems of ventilation are based are either without foundation or doubtful, and that the problem of securing comfort and health in inhabited rooms requires the consideration of the best methods of preventing or disposing of dusts of various kinds, of properly regulating temperature and moisture, and of preventing the entrance of poisonous gases like carbonic oxide, derived from heating and lighting apparatus, rather than upon simply diluting the air to a certain standard of proportion of carbonic acid present. It would be very unwise to conclude, from the facts given in this report, that the standards of air supply for the ventilation of inhabited rooms, which standards are now generally accepted by sanitarians as the result of the work of Pettenkofer, De Chaumont and others, are much too large under any circumstances, or that the differences in health and vigor between those who spend the greater part of their lives in the open air of the country hills and those who live in the city slums do not depend in any way upon the differences between the atmospheres of the two localities except as regards the number and character of micro-organisms.

The cause of the unpleasant, musty odor which is perceptible to most persons on passing from the outer air into a crowded, unventilated room is unknown. It may in part be due to volatile products of decomposition contained in the expired air of persons having decayed teeth, foul mouths or certain disorders of the digestive apparatus, and it is due in part to volatile fatty acids produced from the excretions of the skin and from clothing soiled with such excretions. It may produce nausea and other disagreeable sensations in specially susceptible persons, but most men soon become accustomed to it and cease to notice it, as they will do with regard to the odor of a smoking car or of a soap factory after they have been for some time in the place. The direct and indirect effects of odors of various kinds upon the comfort and, perhaps also, upon the health of men are more considerable than would be indicated by any tests now known for determining the nature and quantity of the matters which give rise to them.

The remarks of Renk upon this point merit consideration.

Cases of fainting in crowded rooms usually occur in women, and are connected with defective respiratory action due to tight lacing or other causes.

Other causes of discomfort in rooms heated by furnaces or by steam are excessive dryness of the air and the presence of small quantities of carbonic oxide, of illuminating gas, and, possibly, of arsenic, derived from the coal used for heating.

AN IMPROVED DEPHLEGMATOR.

By SYDNEY YOUNG, D.Sc., F.R.S., and G. L. THOMAS, B.Sc., University College, Bristol.

VARIOUS forms of still head have been devised for use in the laboratory (vide Thorpe's "Dict. of Applied Chem.," vol i., p. 694), those of Wurtz, Linnemann, Le Bel and Henninger and Glinsky being most frequently used.

Another form of dephlegmator, resembling in construction that employed in the Coffey still, has been recommended by F. D. Brown (Trans. Chem. Soc., 1880, 49), but has not met with the attention it seems to deserve.

We have for some little time made use of a dephlegmator (Fig. 1) similar in principle, but differing from Brown's in construction; and as it has been found convenient, and has given very good results, we think that a description of it may be useful.

A glass tube, about 18 mm. in internal diameter, is sharply constricted at intervals of about 8 cm. (The constrictions may be formed by heating the tube, kept in regular and rather rapid rotation, with a small blowpipe flame, then producing a partial vacuum in the tube by drawing in with the breath.) On the constricted portions of the tube rest disks of platinum gauze, through the center of which pass glass tubes of the form and dimensions shown in Fig. 2.

The vapor passes through the condensed liquid resting on the platinum disks, and the excess of liquid flows down the tubes, resting on the disks.

While the distillation is proceeding, the pressure of the vapor forces the liquid up into the wider part of the dropping tubes; if the tubes are too narrow above the head of liquid, there is danger of bubbles of vapor being caught and carried down, so as to empty the tubes, when the ascending vapor might find an easier passage through the tubes than the gauze. With the tubes constructed as shown in the diagram, this has never been found to occur.

As soon as the distillation is stopped, the level of

FIG I

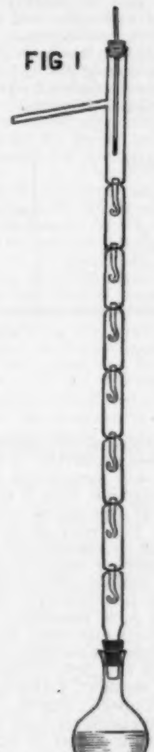
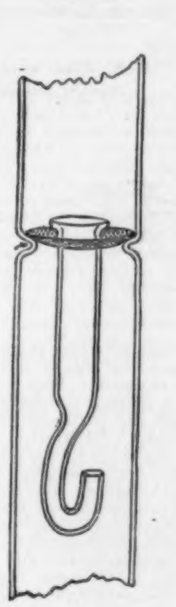


FIG 2



the liquid falls to that at the lower end of the dropping tubes, and this small quantity of liquid is easily recovered by removing the dephlegmator from the flask, and sending a small, but sharp, blast of air through the side tube.

In order to test the efficiency of the dephlegmator, a mixture of 200 grammes of pure benzene and 200 grammes of pure toluene was distilled—(1) from an ordinary distillation bulb with a still head 30 cm. long (from the bulb to the side tube); (2) from a flask with a plain still head, 110 cm. in length; (3) from a flask with a dephlegmator of the same length with seven constrictions.

The results are given in the table below:

Temperature corr. to 760 mm.	Weight of fraction in grammes. Short still head.	Long still head.	Dephlegmator.
80·2 to 83·2	0	0	36·5
83·2 " 86·3	0	1·2	90·6
86·3 " 89·4	9·0	48·4	22·3
89·4 " 92·5	99·4	94·4	20·3
92·5 " 95·6	86·9	51·8	18·8
95·6 " 98·7	54·8	36·3	19·5
98·7 " 101·8	35·8	30·6	15·1
101·8 " 104·8	30·0	26·4	5·3
104·8 " 107·9	30·9	22·0	18·9
107·9 " 110·3 } 110·3 " 110·9 }	53·0	51·9	36·5 / 40·1
Pure toluene 110·9°		36·2	66·1
	399·8	399·2	399·0

It will be seen that the separation with the long still head is considerably better than with the short one, but that neither of the plain still heads can compare at all in efficiency with the dephlegmator.

After three additional fractionations with the dephlegmator, 175 grammes of pure toluene and 60·8 grammes of pure benzene were recovered; two further fractionations of the partially purified benzene brought up the weight of the pure substance to 174·4 grammes.

The weight of each pure substance recovered amounted, therefore, to over 87 per cent.

We are at present using a dephlegmator 135 cm. long with twelve constrictions, the flask being supported by a retort stand and clamp on the floor and the condenser on the working table.—Chem. News.

ARGON: ITS PROBABLE COMPOSITION.

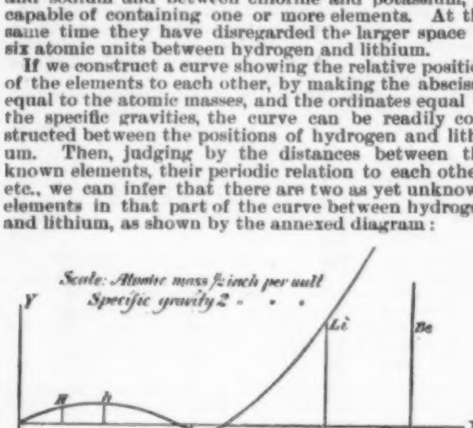
AT the present time one of the most interesting scientific problems is that relating to the newly discovered gas in our atmosphere—argon.

Of several suppositions in regard to its nature, that of its discoverer, Lord Rayleigh, has naturally received the most attention. From premises drawn from the faulty kinetic theory of gases, Lord Rayleigh regards argon as an element having an atomic weight of about 40 or possibly 20, and he seeks to classify it in the list of the elements near the place of potassium. To do this he naturally abandons the great periodic law, for he says: "If argon be a single element, then there is reason to doubt whether the periodic classification of the elements is complete; whether, in fact, elements may not exist which cannot be fitted among those of which it is composed."

According to Mendeljeff's periodic classification of the elements, which is now generally accepted, there can be no new element having the atomic weight of 40, or even of 20. Hence, notwithstanding the conclusions drawn from the faulty kinetic theory of gases, the modern chemist will regard argon as a compound body. Which conclusion is correct?

Lord Rayleigh and others evidently regard the space of four atomic mass units, which exists between fluorine and sodium and between chlorine and potassium, as capable of containing one or more elements. At the same time they have disregarded the larger space of six atomic units between hydrogen and lithium.

If we construct a curve showing the relative position of the elements to each other, by making the abscissæ equal to the atomic masses, and the ordinates equal to the specific gravities, the curve can be readily constructed between the positions of hydrogen and lithium. Then, judging by the distances between the known elements, their periodic relation to each other, etc., we can infer that there are two as yet unknown elements in that part of the curve between hydrogen and lithium, as shown by the annexed diagram:



From my deductions I have arrived at the following opinion in regard to the physical properties of these two elements: The first of the new elements is a metallic element somewhat like hydrogen, and it is probably the hydrogen occluded by the metal indium (helium). Its atomic weight is two, and its specific gravity in the solid condition is slightly greater than that of the first hydrogen, while its melting point is about 100° C. higher. The second new element (the third element of the curve), which I have provisionally named americanum (coronium), symbol A, is remarkable for its very small specific gravity, about one-third that of the first hydrogen and for its very low melting point, about 34° C. lower than that of the first hydrogen. Its atomic weight is four. This element, I think, will help to clear up the doubts pertaining to argon.

The above curve and its correlated curves, while showing that there is no position for argon as an element, also make some changes in the accepted atomic masses, among which is that of phosphorus, changing it from 31 to 30. There are certain reasons for regarding phosphorus to be a compound like ammonium, cyanogen, etc., each of which plays the part of an element.

The relative gaseous density of such elements as can be gasified is supposed to be the same as that of their relative atomic weights, with a few exceptions, among which is phosphorus. The atomic weight of phosphorus, considered as an element, is taken as being one-half its gaseous density, while its molecular weight follows the general rule for simple and compound gases, being twice its gaseous density.

If what we call phosphorus is not an elementary substance, then $P_4 = 124$ is not the molecular formula. Can the true formula be deduced from the above observations? If we consider phosphorus to be a compound substance, then, judging by analogy from other compounds, and by the curve, one of the elements ought to be the true element phosphorus, having an atomic weight of 30. The laws of valency point out that this element should in the compound which we now call phosphorus exist in multiple combination with a previous element on the curve of a certain valence. The compound substance phosphorus is then accurately represented by the formula, $AP_4 = 124$.

The same reasoning will apply to the argon considered as a compound. Besides, if americanum will combine with elementary phosphorus, it ought also under appropriate conditions to form a similar compound with its analogue nitrogen, the formula of which substance would be $AN_4 = 60$. But this substance would be a non-saturated, and therefore an active compound like AP_4, and not an inert and saturated compound like argon. But the formula of the saturated compound of nitrogen is $A_3N_2 = 40$. This solution being in accordance with the laws of periodicity and of valency, the last formula may be taken as that of argon.

If argon is, as is probable, a compound, it must be an exothermic substance; and if the above is its molecular formula, its heat of formation must be very great, because the atomic volume of americanum is exceedingly large. This explains why argon is not decomposed at high temperatures. Its dissociation point is probably higher than that of any other compound gas. W. H. MASSER, United States Navy.

THE ARGON MYTH.

By J. ALFRED WANKLYN.

THE more closely the papers read before the Royal Society on January 31 are examined, the plainer it becomes that the existence of anything like one per cent. of a new substance in the atmosphere has not been established.

In their paper of January 31, Rayleigh and Ramsay make mention of the preparation of "argon" on the large scale; but it is quite plain that such mention is only of a hypothetical kind, and that those operators either refrained from attempting the preparation on a large scale, or, if they had attempted it, they failed to obtain the argon in quantity. The paucity of the product is amusingly illustrated by some particulars which occur in their account of the experiments. Thus, for instance, the specific gravity of the Rayleigh argon was determined—not in about 2 liters of pure argon—but upon a mixture of 400 c. c. of argon with a sufficient quantity of oxygen to fill the specific gravity globe, the capacity of which was about 2 liters. And, indeed, if the reader will refer to the paper which is published in Nature,* he will find that the total quantity of argon obtained by Rayleigh by the Cavendish process did not much exceed 400 c. c. The weight of this 400 c. c. is only about 10 grains, from which it may be perceived how very little has been actually obtained.

The circumstance that in Rayleigh's experiment 6·3 liters of atmospheric nitrogen yielded 65 c. c. of the gaseous residue to which the name argon has been given, while in Ramsay's experiment a much larger quantity of nitrogen, apparently from 100 liters to 150 liters of nitrogen, were required to give 70 c. c. of the gaseous residue, has been mentioned before, and is most significant. The conclusion which can hardly be resisted is that Rayleigh's argon differs from Ramsay's argon in some very essential particulars. There is a point in Rayleigh's experiment to which I would particularly call attention. The 65 c. c. of gaseous residue is almost absolutely the theoretical quantity of argon called for by Rayleigh's theory that the slight difference between the density of atmospheric nitrogen and so-called "chemical" nitrogen is due to the presence of argon. Now, if the details of Rayleigh's experiment be carefully considered, it will be seen that the loss of argon due to its solubility in water must, under the circumstances of that experiment, have prevented the exhibition of more than a fraction of the total argon.

There must have been at least a liter of water in the flask employed by Rayleigh. Water, we are told, absorbs about 4 per cent. of its volume of argon, and, therefore, 40 c. c. would pass into solution in the water contained by the flask. It is quite true that the solution of gases in water does not take place in an instant, but requires a considerable lapse of time; this condition is, however, complied with in Rayleigh's experiment, which extended over many days and afforded ample opportunity for the absorption to take place.

If the account of argon, which Rayleigh and Ramsay give, were correct, there ought not to have been a visible yield of more than half of the 65 c. c. in the Rayleigh experiment; and the obtaining of the 65 c. c. discredits the work altogether.—Electrical Review.

PROCESS OF AND APPARATUS FOR NITRIC ACID, TAR AND OTHER LIQUIDS.

WHEN a mixture of saltpeter with sulphuric acid, in suitable proportions, is heated, even at so low a temperature as 50° to 60° C., the hydro acids of the halogens (particularly noticeable when the niter contains much sodium chloride) are oxidized with liberation of the halogens and production of oxides of nitrogen. To remove these by action of a continuous current of air or of an inert gas, passed into the mixture from the beginning of the heating to the termination of the process, admits of obtaining a distillate of nitric acid of high purity, the apparatus shown and described below being used.

Air or inert gas is forced through the tube, B, into the mixture of sulphuric acid and niter contained in

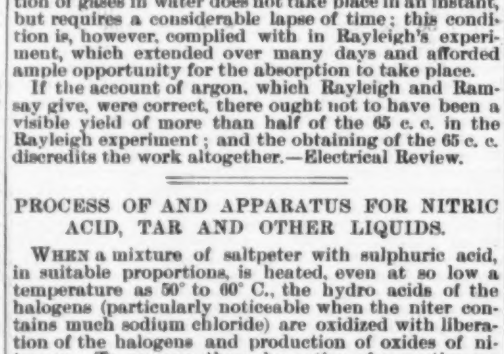
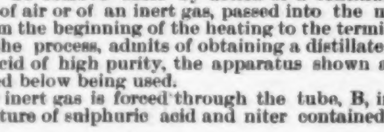


Fig. 2.

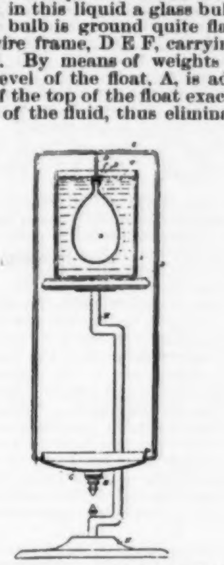


the heated receptacle, A. The tube, d, passes into the cooler, from the lower coils of which small branch inclined pipes, a, pass into the large tube, b, shown in plan in Fig. 2. This tube, receiving the less condensable products of the distillation, terminates in a suitable reservoir, provided with a siphon cock, h; the upper part of the tube, b, may be connected to an absorption apparatus. The air first separated is returned to the still. The first portions of the distillate are liable to be colored and have a chlorine reaction: to obtain these portions separately, the cock, g, is at first kept closed, while the cock, f, in the branch pipe is open. The action of these cocks is reversed when the pure acid comes over, which then enters the receiver, K. The acid condensed in the pipe, b, is stronger than that entering the cooler, and it may be allowed to drip continuously from the siphon valve, h, or that valve may be closed, so that the acid may pass through the lowest pipe, a, of the last coil, y, into the receiver. A modified form of the apparatus is also shown in the original drawing. The cooler may be made of glass or metal, and "is suitable for all kinds of distillation in which corroding gases are produced, such as, for instance, in the distillation of tar or the like."—W. Dieterle, Feuerbach, near Stuttgart, and L. Rohrmann, Krauschwitz, near Muskau, Germany.

FLOAT FOR SPECIFIC GRAVITY DETERMINATIONS.

By T. LOHNSTEIN, Berlin, Germany.

THIS consists in a stand, K, supporting the cylinder, I, which contains the liquid of which the specific gravity is required; in this liquid a glass bulb, A, floats; the neck of the bulb is ground quite flat, and is attached to the wire frame, D E F, carrying a pan, G, and a pointer, H. By means of weights placed upon the pan, G, the level of the float, A, is adjusted until the sharp edge of the top of the float exactly coincides with the surface of the fluid, thus eliminating the error due to capillarity. The instrument may also be used as a balance for determining the absolute weight of solid bodies.



FLOAT FOR SPECIFIC GRAVITY DETERMINATION.

PEPTONE.*

IT was in the early years of the present century that the most important discovery was made that the secretion of the glands of the stomach is an acid one; and Carl Schmidt was the first to show with analytical certainty that it is hydrochloric acid which is, par excellence, the acid of the gastric juice. The presence of other acids like lactic acid is more or less accidental. The absence of putrefaction in the normal gastric contents was noted by Spallanzani, and is caused by this acid. There can be no doubt that the antiseptic action of the juice, which is very great, serves us in good stead by protecting us very largely from the evil results which would otherwise follow the introduction of numerous microbes with every meal. But it is with gastric juice as a digestant that we have now to deal. The first observers were inclined to attribute the solvent power of the juice to its acid; but, as Dr. Beaumont showed in his classical observations on Alexis St. Martin which have laid the foundation of all our modern knowledge on digestion, this could not be the case. An acid of the same strength is a less powerful solvent, and therefore the gastric juice must contain a special solvent principle. This Eberle supposed to be the gastric mucus, a supposition easily refuted. It was Schwann who discovered this special principle and called it pepsin. He gave the name albuminose to the product of its action on albumin; Lehmann's name, peptone, however, has since been generally adopted. Lehmann recognized that peptone is not coagulated by heat as albumin is.

The modern conception of the process of proteolytic digestion in the stomach is the following: Gastric juice acts on proteids in virtue of the compound between pepsin and the acid which it contains. This compound may be styled pepsin-hydrochloric acid. Like that of most other ferments, its action is a hydrating one, and similar products may be obtained by other hydrating agencies, such as heating with dilute mineral acids or superheated steam. The final product of this action is called peptone, and this substance, compared to the original albumin, is very diffusible. But between the albumin and the peptone are several intermediate stages of intermediately diffusible substances. One of these produced in small quantities is acid albumin, but the greater number come under the general heading of the proteoses.

The pancreatic digestion of proteids is closely similar; it, however, occurs in an alkaline medium and is more energetic, and, moreover, if long continued, leads to a breaking up of some of the peptone into simpler nitrogenous substances like leucine, tyrosine, aspartic acid and ammonia.

It should be mentioned that though highly diffusible compounds like proteoses and peptone are formed in the alimentary canal, none find their way as such into the circulating blood, even during the periods of most energetic digestion. These substances are, in fact, pretty powerful poisons when injected into the blood stream. The epithelial lining of the alimentary canal normally protects us from these toxic products by once more dehydrating the peptone in virtue

* Also published in our SUPPLEMENT, No. 1009.

* From Science Progress, March, 1895.

of the vital activity of its cells. Though lymphoid tissue, which is abundant in the intestinal walls, has been considered by some to have a share in this action, most observers are pretty well agreed that it is the columnar epithelium which is the main agent in the "regeneration of albumin."

But to return to the products of digestion, it was very soon recognized that they are numerous. Meissner described the varieties of peptone as parapeptone, dyspeptone, metapeptone, a, b and c peptone. Schmidt-Mulheim distinguished between parapeptone, propeptone and peptone. Parapeptone is the acid albumin, and propeptone is a very good name for what we now call the proteoses. Nearly all of our present knowledge of the chemistry of digestion is due to the work of Kuhne and those associated with him in his researches, particularly Chittenden and Neumeister. A most valuable method of isolating peptone was discovered by Wenz, one of Kuhne's pupils. It consists in the use of ammonium sulphate as a reagent; when added to saturation this salt readily precipitates all proteids except peptone. Pure peptone was never obtained previous to this, but always more or less mixed with proteoses.

The earliest of Kuhne's observations showed him that there are two varieties of peptone, hemi-peptone, which by the pancreatic juice is further split into leucine, tyrosine, etc., and anti-peptone, which resists this action. The corresponding intermediate proteoses may be termed hemialbumose and anti-albumose respectively.

More recent observations have shown that albumoses may be classified in another way, according to their reactions and solubilities, into:

1. Proto-albumose; soluble in hot and cold water and dilute saline solutions, but precipitated by saturation with sodium chloride or magnesium sulphate.

2. Hetero-albumose; insoluble in water and therefore precipitable by dialyzing out the salt from its solutions. Otherwise it closely resembles proto-albumose.

3. Deutero-albumose; soluble in hot and cold water, and not precipitated by saturation with sodium chloride or magnesium sulphate, but it is by saturation with ammonium sulphate. It is thus in its reactions nearest to the peptones.

Peptone itself resembles these albumoses by giving the biuret reaction (pink color, with copper sulphate and caustic potash), but differs from them in not being precipitable by ammonium sulphate nor by nitric acid.

Neumeister has succeeded in discovering the relationship between these two classifications of the albumoses. Albumin may be considered to be composed of hemi-albumin and anti albumin; the hemi-albumin in the first stage of hydration is split into proto-albumose and hetero-albumose; the anti-albumin yields hetero-albumose and acid albumin. The next stage in hydration is deutero-albumose, and the final step is the conversion of the deutero-albumose into peptone of the hemi and anti varieties.

The albumoses (proto and hetero), formed directly from the albumin, may be called primary albumoses. Deutero-albumose is a secondary albumose, and is thus nearest to the peptones, not only in its reactions, but also in its order of formation.

The similar products formed in the digestion of globulin may be called globuloses; of vitellin, vitelloses; of casein, caseoses; of myosin, myosinoses; there are individual minor differences, but all are closely similar to the albumoses, already described, and the general term preteoses includes them all. The products of digestion of elastin and of gelatin have also a general resemblance to the proteoses and peptone.

Such, briefly, is a summary of our knowledge of proteolysis produced by gastric digestion. But within the last year or two further points of detail have been taken up and worked out, and it is to these that it is the special object of this paper to draw attention. In so doing, it will be necessary to restrict our consideration to those papers in which peptones and albumoses are treated from the digestion point of view. It would lead us too far to take up another branch of this subject which has recently attracted so much attention, namely, the chemical action of micro-organisms and the poisons they produce. Suffice it to say, that in numerous instances the toxines and antitoxines of bacteriologists are proteoses or substances closely allied to them.

Pekelharing* has attempted to throw doubt upon the individuality of peptone and upon the ammonium sulphate method of isolation, claiming that proteoses are only partially precipitated by the ammonium salt, and that the so-called peptone is merely a mixture of albumose or proteose, with some unknown substance or substances. In support of this view, he apparently finds it impossible to prepare a peptone which will not yield some proteose by treatment with ammonium sulphate, or which will not show the presence of proteose by such reagents as trichloracetic acid.

This criticism has led to renewed research on the part of Kuhne,† in Heidelberg, and of Chittenden,‡ who now works independently of his old master in the laboratory of Yale University.

In his first paper Kuhne states in general terms that a solution containing a mixture of proteoses and peptone gives a precipitate of proteoses when saturated with ammonium sulphate, the peptone remaining in solution. After filtration, the filtrate if set aside, will subsequently give a further precipitate, if more salt is added. This has been explained by supposing that the saturation was in the first case incomplete, or that the peptone is partially changed back into proteose. He proceeds to show that the former is the more probable explanation. There are many precautions necessary in order to precipitate the last traces of proteose. It is necessary in the first instance to use large volumes of the saturated solution in addition to merely adding crystals of the salt to the proteid mixture. Further, it is found that whereas the greater part of the proteose is precipitated by the salt if the reaction of the mixture is made acid, the residue, which is difficult of precipitation, comes down more readily if the reaction is made alkaline. It is further necessary, after the solution of peptone is obtained, to remove the salt employed; this may be accomplished by the use of barium carbonate after concentration. If pancreatic juice is used for the preparation of peptone, care must be taken to remove leucine and tyrosine also. In drying, concentrating, etc., especially if sulphuric acid is used, a brownish product is formed; this is minimized by care in the manipulations. This substance is precipitated by ammonium sulphate; it is not, however, albumose; it gives no biuret reaction. Further, if a precipitate forms on dialysis, it is not necessarily of proteid nature; if hard water is used, it may be calcium sulphate.

Pekelharing does not seem to have recognized the necessity of these and other precautions and details; and, moreover, the differences between peptone and proteose are very striking. This aspect of the subject is considered more fully in Kuhne's second paper. There are not only differences in solubility, but differences in elementary composition, differences in behavior to such reagents as metaphosphoric and trichloracetic acids; and peptone when dry stands alone among the products of proteolysis, by hissing like phosphoric anhydride does on the addition of water.

Chittenden takes up the matter from rather a different point of view. He has considered it necessary to repeat his old experiments with as pure a specimen of proteid as he has been able to obtain, instead of using white of egg or other similarly impure raw materials. The proteid he has selected is the crystallized globulin or vitellin from hemp seed. He also entirely disagrees with Pekelharing, as under these more stringent conditions he confirms his older work; he, however, makes a few new points, and so a brief resume of the entire paper may not be unprofitable.

He performed two separate digestions on a large scale, one of which was continued for three, the other for ten days. The products of digestion were carefully separated from one another and analyzed; their reactions are exhaustively described, including their specific rotatory power. In separating proteoses from peptone the difficulties of manipulation are recognized, and so far as is at present possible obviated. The investigation, however, lends no support to Pekelharing's views, but is in complete accordance with Kuhne's contention that peptone is a definite, well-characterized substance. Its amount increases, and that of proteose diminishes as digestion progresses, but an artificial digestion in which all proteose is converted into peptone has not yet been obtained. The progressive changes from primary proteose to deutero-proteose and peptone are most marked in the early stages of digestion; the disappearance of deutero-proteose and the formation of peptone is subsequently a very gradual process.

In the proteolytic process, at least four products of hydration and cleavage are easily recognizable, namely, proto-proteose, hetero-proteose, deutero-proteose and peptone. The examination of the percentage composition of these substances shows a gradual and progressive falling off of carbon as digestion progresses. But the tables given show another very noticeable feature, and that is that the percentage composition of the individual proteoses differs in the two digestions; the substance called proto-vitellose, for instance, in the digestion carried on for three days, cannot be the same as that with the same name in the digestion carried on for ten days, although both give the same reactions, specific rotation of the plane of polarized light alone excluded. This cannot be due to analytical errors; a skilled investigator of Professor Chittenden's eminence could not fall into such a mistake; besides other proteids, egg white, for instance, under the influence of superheated steam gives similar results.

The explanation advanced is that the four substances named merely represent the main steps in the hydration process, but that there are further links in the chain mixed with these, which cannot at present be separated, and which manifest the same general chemical behavior.

Such a result is not altogether unexpected; it only shows how, in spite of the advance of chemistry as a whole, it is practically at a standstill so far as the proteids are concerned; nor can we hope to understand the steps in proteolysis until the chemists are able to give us some idea of the chemical constitution of the proteids which these digestive juices act upon.

One of the properties alluded to, which the proteoses and peptones agree in possessing is their power of diffusing through membranes; and, although these products of digestion do not avail themselves of this to the full, for we never find them in the blood, it can hardly be doubted that the formation of diffusible from indiffusible substances must fulfill some useful end. It appears to be the main object of all digestion, whether of proteids or carbohydrates. It may be held that it enables the substance to be absorbed to start on its journey, though in the progress of that journey bloodward the property in question is lost.

The same two names are associated with the investigation of this point with accuracy. They worked independently and arrived at the same result. To take Chittenden* first. He found that the proteoses, though diffusible, were not nearly so much so as peptone. A curious fact which was unexpected was that deutero-proteose is less diffusible than proto-proteose. Protogelatose is fairly diffusible, but it has a somewhat lower endosmotic equivalent than the corresponding proteose. Elevation of temperature increases the rate of osmosis, especially of the proteoses.

I give in conclusion the figures from Kuhne's paper,† which illustrate these facts. Hetero-proteose is the least diffusible of the proteoses; in neutral saline solutions it is precipitated, and none passes through the dialyzer; dissolved in ammonia it loses 5·22 per cent. Deutero-proteose comes next (loss 24·1 per cent.); then proto-proteose (loss 21·3 per cent.); while peptone loses 51 to 51·8 per cent. W. D. HALLIBURTON.

* Centralblatt f. Physiol., vii., p. 43.

† Zeit. Biol., xxix., pp. 1 and 308.

‡ Jour. of Physiol., xvii., p. 48.

* Journal of Physiol., xiv., 483.

† Zeit. Biol., xxix., 1.

WHEELING IN MUNICH.

AMERICAN bicyclists who are governed by reason and a proper regard for the rights of others have little cause to complain of the restrictions placed around their sport in most cities of this country. Having won the right to have the bicycle regarded as a vehicle, with the rights and privileges of a vehicle, they are content to submit to the regulations that the community finds it necessary to make for the government of all vehicles. When additional restrictions are imposed, however, by local authorities, which think the exceptional nature of the bicycle requires exceptional precautions for the safety of the public, they are likely to begin to "kick" and to demand that their rights be restored. But American bicyclists who have had experience abroad, especially in German cities, find that even the most finical and nervous American town council's ordinances breathe a spirit of absolute freedom compared with the intricate system of hindrances that the local authorities in many German places set round about the riding of bicycles in their streets.

A party of enthusiastic riders was whiling away the tedium of a rainy holiday afternoon the other day by exchange of experiences, when the matter of riding abroad came up. Of course the good roads of England and the Continent were discussed in all their aspects; no bicycle symposium would ever be completed without that. When they had been praised to the envy and despair of the men who had never been abroad, and who didn't see any prospect of getting there, at least not till their riding days were over, one who had had the good or bad fortune to live in Germany for a considerable time turned a little light on the other side of the question.

"There are some drawbacks even to riding on the sandpapered roads of Germany," said he, "as my experiences as a resident of Munich will show. I began my bicycling career in that Bavarian capital, and I can tell you that the life of a beginner there is made a burden to him, for a while, at any rate. Now, I had always heard that the German government was a paternal government, and all that sort of thing, but I never fully appreciated the meaning of the phrase till I had finished my course of preliminary instruction in the bicycle hall and was thinking of going out doors for my first ride. Then I came up against paternalism with a heavy thud.

"When I broached to my instructor the subject of going out doors to ride, he remarked, with the air of doing me a considerable kindness, that he would attend to sending my preliminary papers to the police. I didn't know what I had to do with preliminary papers or with the police, upon this occasion, anyway, though, notwithstanding a blameless life, I had frequently come in contact with them before in various places, under circumstances calling apparently quite as little for police interference—generally, in fact, as it seemed, for the purpose of being allowed to exist at all.

"Well, my instructor sent off my papers, which, it seemed, were an application to the board of police commissioners for the privilege of appearing before them to undergo an examination, and his own indorsement of my candidacy as a quiet, law-abiding moral person, who had attained sufficient proficiency on the wheel not to be a menace to the community. I am rather timid and retiring and averse to the sharp and domineering methods of the German police, and was alarmed at the prospect of the ordeal which awaited me; but I had seen people riding the bicycle in Germany, and was resolved that if others could confront the police unscathed and obtain the right to indulge in the revolutionary, anarchistic and generally suspicious practice of bicycle riding, I could do it too. So I devoted myself with renewed ardor to practice in the hall.

"It was well that I did so, for in a day or two I received under a government frank an imposing document from the police department of the city of Munich, informing me that I was accepted as a candidate for bicycle riding, and summoning me to appear before the board on a certain day, at a certain hour, at a certain street corner, there to undergo a trial of my ability as a wheelman. In fear and trembling I trundled my wheel thither when the hour arrived—of course, it couldn't be ridden until I had gained my diploma—and there I found about a score of other luckless beginners, likewise fearing and trembling, and a highly uniformed official. I identified myself with my 'papiere,' the passport that was so useful on many another occasion when German officials were to be impressed—and took my place in the line. Candidates were required to mount, ride a block or two, turn around, ride back and dismount. As an examination, it was a 'pudding,' as we used to say at college, and I don't think anybody failed to pass with a high mark; but the majesty of the law was vindicated and the safety of the commonwealth safeguarded. We each paid the official fifty pfennige, and after giving our names and addresses, went home. In two or three days I got a bulky package containing an assortment of official documents from the police department. One was a long list of rules and regulations governing the conduct of bicyclists in Munich. The section of chief interest was that defining the limits within which bicycles could not be ridden. On studying my map, I found the forbidden district included most of the business portions of the city; the English Garden, a large park, about corresponding to Central Park in size and importance, and the passage through a certain gateway, where, for some reason I never could learn, bicyclists were obliged to dismount. The English Garden was closed to bicyclists because at one time a member of the royal family of Bavaria was riding therein when his horse was frightened by a passing wheelman.

"The bulky parcel also contained a card bearing my name, a number and the full title and seal of the police commission. This, it was stated, I should always have upon my person to show to any policeman who might choose to stop me and demand to see my credentials. Then there was a little enameled steel plate bearing the same number as that upon the card, which was to be fixed to the head of my machine, and which was to be general prima facie evidence that I had been inspected by the police authorities and had the right to ride, though it did not absolve from the necessity of carrying around the diploma itself. Last, but not least, was a demand for the remittance of two marks fifty pfennige.

"The thing that may surprise New York bicyclists is that these rules were all strictly enforced. I was stopped several times by policemen with a demand to show my card; and many a time, as I unwittingly crossed the 'dead line,' having neglected to memorize

the streets forbidden to riders as thoroughly as the German mind demands, have policemen chased me and roared after me, to dismount. I always obeyed promptly; it doesn't pay to defy the German police.

"Such is, or was, a few years ago, bicycling in Munich. It is the most paternal regulation of the sport I ever encountered, even in Germany. It was much simpler in Berlin; riding there was absolutely prohibited, except in the Thiergarten. There are severe restrictions in all the large cities. One may imagine I felt lost on my return to America, as I could ride without having to think of deadlines, police credentials or anything but a bell by day and a lamp by night, with the exuberant feeling that if I wanted to get killed on my machine there would be no police interference—till after it had happened."—New York Tribune.

THE DOOM OF THE SMALL TOWN.*

GROWTH and prosperity, in a country which has not yet attained its full development, are practically identical. To lose population, to decline in trade, in industry, in wealth, in public spirit—these are the signs of decay. France is the one nation of Christendom which makes progress in art, industry, and commerce while stationary in population. In the United States, on account of the restless activity of the people and their easy transition from place to place and from one vocation to another, the locality which loses its inhabitants loses also its energies and sinks into lethargy. The decline of large cities, whenever it has occurred, has attracted universal attention, but less heed is paid to the decay of villages. One by one, family by family, their inhabitants slip away in search of other homes; a steady but hardly perceptible emigration takes away the young, the hopeful, the ambitious. Their remain behind the superannuated, the feeble, the dull, the stagnant rich who will risk nothing, the ne'er-do-wells who have nothing to risk. Enough workers remain to till the soil, to manage the distribution of food and clothing, and to transact the common business of life; but the world's real work is done elsewhere.

Such a silent tragedy is enacted to-day in a multitude of small communities scattered throughout the North Central States. All these small communities had their period of active growth; many of them, indeed, grew too fast, some dried up and perished. Their people look back sorrowfully to the time when the railroads were built, when the mills were grinding, when town property was worth more than it cost. That happy period was from ten to thirty years ago. The general decline of the small municipalities of the West became most noticeable during the decade from 1880 to 1890. The facts that had been obvious to every one familiar with this region were then tabulated in the census reports.

The States of Ohio, Indiana, Illinois, and Iowa may be selected as representing the richest and best watered region in the United States. Area for area, they probably surpass any other part of the United States in varied general productiveness. In the breeding of horses, Illinois is first among the States of the Union and Iowa second; in number of cattle, Iowa is second and Illinois is third (the first being Texas); in the value of live stock, Iowa is first, Illinois is second; in the number of swine, Iowa is first, Illinois is second; in the production of corn, Iowa is first, Illinois is second; in the production of wheat, Illinois is second, Indiana is third, Ohio is fourth. These States are served by many railroads; indeed, Illinois had the greatest railroad mileage of all the States in the census year and Kansas the next greatest; Iowa came third, though these relations have since changed. Indeed, it may be asked whether these States have not an embarrassment of this kind of riches when it is considered that Iowa, with less than two millions of people, has more miles of railroad than New York, with six millions. These States, moreover, lie in the very heart of the continent, and directly in the path of interoceanic travel and commerce. Their citizens are intelligent, education is universal, and the climate is neither too hot nor too cold.

Yet in these rich States, empires in themselves, and in the finest counties of each, forces are at work to check the growth and stifle the vitality of nearly half their townships. The following table, prepared from the census returns, shows the number of townships in each of these States which, during the decade from 1880 to 1890, made some gain in population, how many stood still, and how many lost:

States.	Townships stationary in population, 1880-1890.	Townships gained population.	Townships lost population.	Total townships.
Ohio	32	529	755	1,316
Indiana	16	496	482	994
Illinois	45	579	800	1,424
Iowa	29	898	691	1,618
Michigan	22	506	416	944
Totals	144	3,008	3,144	6,291

Cook County, Illinois, is not included; neither are other counties whose township boundaries have been changed so as to preclude comparisons; but these would not relatively change the table.

A map of these States, showing the counties darkened in which the greatest depopulation has occurred, would be blackest in the eastern half of Iowa, in all the northern and western parts of Illinois, in northern, southeastern and central Indiana; and southern Michigan and the southern half of Ohio would be very black indeed. Many counties show an aggregate gain although nearly every township in these counties, except those containing the chief towns, sustained a loss. In some cases, though a majority of the townships show a slight increase, the falling off in others has been so large as to throw the whole county into the retrograde column. This shrinkage is seen in sharp contrast when it is remembered that during the same period every one of these States gained during this decade very largely in population, the increase in Ohio being 474,000, or nearly 15 per cent.; in Indiana, 214,000, or 10·8 per cent.; in Illinois, 748,000, or 24·3 per cent.; in Iowa, 287,000, or 17·6 per cent.

* From the Forum, April, 1895.

In Michigan, the population of at least half the townships in every county in the four southern tiers, excepting Allegan, is either stationary or declining rapidly; and many of those counties do not contain more than three or four townships that have increased their population by a single soul in ten years. This broad belt of excellent fruit and farming land, with the northern tier in Indiana, which is in the same course of gradual depopulation, is "gridironed" with trunk line railroads. A similar area stretches between Chicago and Cincinnati and between Chicago and St. Louis. Indeed of Illinois it may be said that the entire State, north and west of a line from Chicago to St. Louis, is undergoing a rapid transformation; for its rural population is drawn into the larger cities and to other States, and its business industries are moving away or declining. Five great railroads cross Iowa from west to east, all passing through northern Illinois to Chicago. At least half the townships in almost every county in the eastern half of Iowa, and in many counties almost all the townships, show a decided loss of population.

Many of the older States of the East and South show the same tendencies, probably in less degree; but these North Central States, by reason of their natural advantages, offer a more striking illustration of the remarkable influences now at work. The rich strip of counties in Iowa lying along the Mississippi show utter stagnation during the last decade, 1880 to 1890. These counties have each from fifteen to twenty townships; and each contains one or more towns of sufficient size to have been the beneficiary of the shifting of population. Beginning at the northern boundary of the State, the number of townships in each county that have positively declined during a period of general improvement throughout the country is one hundred and thirty-four.* On the other side of the river, in Illinois, in one hundred and seventy-four townships stretching in an unbroken line along the river from Wisconsin to St. Louis, the same state of things exists.† The great waterway from north to south has not in the least checked the tendency to depopulation. East and west, along the great railroad lines, the decline is equally manifest. The counties along the line of the Chicago, Rock Island & Pacific Railroad from Des Moines to Chicago show two hundred and six retrograde townships;‡ and on east from Chicago to Detroit, along the Michigan Central, one hundred and twenty-five townships are in a like condition.§ On these two lines of railroad, therefore, stretching from Des Moines to Detroit, a distance of more than five hundred miles, all the small communities, excepting those immediately adjacent to Chicago, have steadily declined in population. Many which are classed as "increasing" show a growth of from only ten to fifty per ons in ten years, which, in view of the rapid growth of the cities, might fairly be deemed decline.

For five hundred miles, then, in a straight line through four States, some evil influence is at work to arrest the growth and destroy the prosperity of all the groups of population which are too small to resist it. They are all served by one railroad, which is abundantly sufficient for their needs, but few of them enjoy the benefits of competition. Separately, they are too insignificant to have any voice in determining the amount of their taxation in the shape of transportation charges. Thus, year after year they have seen their hopes deferred, their business dwindle, their young industries starved out, their most enterprising citizens depart, until dilapidation seems their natural condition, and public spirit dies away. It is not surprising to find that when the people move away they close up their shops and mills; or probably it would be more accurate to say that, being compelled to abandon their means of livelihood, they went elsewhere in search of that employment which their own communities denied them.

The chief productive industries in small Western communities have been the manufacture of agricultural implements, of brick and tile, cooperage, grist mills and flouring mills, foundries and machine shops, saw mills and mills whose products are made from logs and bolts, the making of furniture, wagons and carriages.

Twenty years ago all these trades flourished in almost every village of a thousand or more people. I have been familiar from childhood with one such town where the following branches of manufacture were once in active and profitable operation: 4 flouring and grist mills, 3 saw mills, 5 wagon and carriage shops, 3 woolen mills, 3 furniture and cabinet shops, 1 foundry and machine shop, 2 cooper shops, besides many smaller industries. All the flour mills are silent to-day, though two new ones have sprung up in their places, operated by steam instead of water power; all the saw mills are gone; all the wagon and carriage shops are deserted, or at best, do a little repairing; two of the woolen mills belong to the past and the remaining one does a small business; and cabinet making is hardly any more a recognized trade. One by one these little centers of industrial activity succumbed to the inevitable; every one of them tells a sad story of heroic struggle with conditions which they but dimly understood and were powerless to resist. Yet this region is a portion of the State of Iowa where crops never fail and where nature has done everything to encourage a prosperous population.

How extensive and all-pervasive have been the influences which combined to smother the dawning life of the small towns and villages throughout this North Central part of our country is shown by the following condensation of the census reports in those branches of industry that I have named in the four States of Michigan, Indiana, Illinois and Iowa.

Yet in each of these States the total number of "plants" has considerably increased, and a large increase in the number of their employes is shown. It is evident, therefore, that there has been a rapid concentration in larger shops and mills, coincident with

* Allamakee County, 16 townships have lost population; Clayton, 12; Dubuque, 15; Jackson, 16; Clinton, 15; Scott, 14; Muscatine, 11; Louisa, 13; Des Moines, 9; Lee, 14.

† Jo Daviess County, 17 townships have lost population; Carroll, 11; Whiteside, 17; Henry, 22; Rock Island, 15; Mercer, 11; Hancock, 21; Adams, 20; Pike, 17; Calhoun, 3; Jersey, 8; Madison, 13.

‡ Polk County, 14 townships; Jasper, 14; Poweshiek, 13; Iowa, 15; Johnson, 19; Muscatine, 11; Scott, 14; Rock Island, 15; Henry, 22; Bureau, 22; La Salle, 23; DeKalb, 11; Kendall, 8; Kane, 3; Dupage, 2.

§ Lake, 4; Porter, 6; Laporte, 9; Berrien, 8; Cass, 12; St. Joseph, 13; Branch, 14; Calhoun, 16; Jackson, 16; Washtenaw, 18; Wayne, 9.

DECLINE OF VILLAGE INDUSTRIES.

		Agricultural implements.	Brick and tile.	Cooperage.	Flour and grist mills.	Foundries and machine shops.	Saw mills.	Furniture and cabinet making.
Iowa	1880	58	980	112	713	102	338	175
	1890	34	260	91	441	126	137	92
Illinois	1880	230	626	(a)	1,094	299	640	373
	1890	100	604	(a)	647	408	357	356
Indiana	1880	96	785	265	906	120	2,022	373
	1890	54	764	170	723	206	1,608	196
Michigan	1880	143	179	265	706	230	1,649	229
	1890	65	185	181	544	260	1,918	228

(a) Figures not accessible.

an expansion of the volume of work. There has been a struggle between the municipalities of the country, in which every town and city is doing its best to stifle its smaller neighbors on the one hand, and on the other hand to maintain itself against greater competitors. In this warfare, the smaller the town, the more it suffers. Especially when the prodigious influence of the railroad system is exerted to help the great cities in the work of destruction, the plight of the little places is hard indeed. As between two equal competing towns, the one that is favored even slightly by railroad rates will win; as between a terminal city enjoying cheap competitive rates and a village doomed to suffer such charges as the railroad managers see fit to impose, there is no prospect for the latter but gradual extinction.

The interstate commerce law, and the commission created thereby, appear to take it for granted that towns having two railroads have certain rights that those having only one road have not. No discrimination between individuals at the same point is legal. Yet although the railroads are coming to be regarded more and more as constituting a single organic system, which ought to bear with equal and uniform pressure upon all and to diffuse its benefits equally, it seems to be quite generally agreed that charges shall be least to the great cities, because they are great, and highest to the little villages, because they are small and helpless. Even the law which is designed to correct these irregularities so far as they occur on any given line of railroad, by prohibiting the charging of a greater sum for a shorter haul than for a longer over the same line and going in the same direction—the so-called long-and-short-haul clause of the commerce law—has in practice been much ignored by the railroads; and the complexity of the railroad system makes its enforcement a matter of extreme difficulty.

It must be admitted that the question how fairly to regulate the charges on staple products, which are shipped in train or car loads to distant markets, is one of the greatest difficulty. Large areas in the West have increased in wealth almost solely because minimum through rates have practically brought them nearer to the seaboard than the farms of western New York are. When the agriculture of the North Atlantic States came into competition with the new cheap lands of the West through the general practice of hauling a thousand miles for a small fraction of the proportionate charge for a hundred miles, and in many cases for a smaller actual charge, there was an instant and rapid sinking of value in the East. During the decade of the seventies, the North Atlantic group of States lost in the value of their farming lands $263,000,000, and during the eighties, $356,000,000. This great depreciation, however, was due as much to the superior productiveness of Western lands as to the advantage they had in the matter of rates. But in the case of the North Central group of States, whose vicissitudes we are now studying, they have no competitor in the quality or the productiveness of the soil; and accordingly, no diminution of farm values has occurred, but, on the contrary, there has been a constant and steady appreciation.

The census of 1890 shows a gain of $119,000,000 in the value of farm lands in Indiana, $253,000,000 in Illinois, $290,000,000 in Iowa; and in all the North Central group, $1,940,000,000. Superintendent Porter, of the eleventh census, attributes the damage sustained by the rural population of these States to the destructive effect of agricultural competition with the States farther west. This can be true only in part, and in so far as the far Western States have unfair advantage in the railroad charges. The drought-stricken regions of Dakota, Nebraska, and Kansas can never compete with Iowa, Illinois, Indiana and Ohio strictly on their own merits.

Relative situations have changed, and the same discrimination which formerly worked so potently in the development of these States and so destructively to the agriculture of the East is now building up the newer States at the expense of the North Central States impelling emigration to the West and Northwest; and at the same time the ever-present forces of centralization are drawing the rural and village population into the larger centers. In this double movement of wealth and population, the unregulated power of railroad managers to fix rates is a most important factor.

But whatever be the causes, unless present tendencies be arrested, the future of the small towns is extremely discouraging; and it is very doubtful whether any material change in existing conditions will soon occur. The superior economies of the factory system of manufacture will doubtless continue to operate unfavorably to small industries. One of these economies is the cheap rates of transportation given to large producers and to great competitive centers; and, until the unification of the railroad system is carried to its logical completion and in some way, either by the elimination of competition between the different parts of the system through government regulation, by the legalization and perfection of pooling, or otherwise, freight rates are made substantially fair and uniform throughout the country, no great improvement in the condition of Western rural communities can be expected. The grand march of improvement which is creating many splendid cities will go on unchecked, but for these the villages will be only feeders.

These tendencies have long been noticed; indeed, it would have been impossible to travel extensively throughout the West and Northwest without being struck on every hand by the evidences of arrested de-

velopment in nearly every hamlet. Mr. A. B. Stickney, in his book, "The Railway Problem," says:

"When a village has a few stores, a blacksmith, a shoemaker, and a carpenter, the wants of the adjacent territory are supplied. To increase beyond this point requires the introduction of manufactories and the larger class of tradesmen or jobbers. Every village in a new country has expectations. On these are based the value of its town lots, and the wealth, or expected wealth, of the villagers. It is true that with the fairest and most equitable railway tariff a majority of these expectations would come to naught; but with a discrimination of ten to fifteen cents per hundredweight against them, there is no hope. At the time under consideration, the villagers had begun to realize the hopelessness of their situation. All their brightest business men were moving to the cities, and the few manufacturing establishments that had started in a small way had either moved or foresaw that unless a speedy change came they must move."

The period Mr. Stickney refers to is the early years of the railroad development in the Northwest; but the fact that all the conditions he mentions were still in full tide during the last decade argues the continuance of similar causes. It is not believed that any check in these tendencies was noticeable prior to the panic of 1893.

There are compensations even for the protracted stagnation which has been described. Each of these little places has been a veritable haven in the midst of the financial storm which, for the last two years, has swept the cities. In seas where no ships sail no wrecks are seen. Where there are few wage earners, no corporation bubbles, no fever of speculation, no overbuilding, no inflation of values, there is little to fear from panics. A panic is a day of judgment for all commercial iniquity, and for all financial folly as well; and the hamlet has no great sins to answer for. Throughout at least a large portion of this region the effects of the intense depression have been but little felt in the small places, and when felt at all they have been felt indirectly. The banks were full of money, and their only losses were incurred by carrying the paper of the banks, trust companies, building and loan associations, debenture bond companies, and the thousand and one rotten institutions with which the cities have been infested. The markets being flooded with unsalable goods of every description, the hard cash of the thrifty farmer and the frugal villager felt a relative appreciation, and came cautiously forth in search of bargains. This condition will doubtless last until a general revival of business, when the current toward the city will again set in. But just at present, many an idle mechanic and many a stranded adventurer in the cities sighs regretfully as he thinks of some country village left behind him, and with the Hoosier poet longs to go—

> ". . . back to Griggsby's Station—
> Back where we ust to be so happy and so pore."

One of the serious consequences of the drawing away of the youth and energy of the villages and towns is found in the benumbing effect it has upon those who remain behind. There is little incentive to start new enterprises, and especially is there small encouragement for boys to learn skilled trades. Hence the prospect before the boys of these villagers is depressing in the extreme. There is practically no chance for a boy to become skilled in any trade except in the building trades, the blacksmith shops, and in the commonest handicrafts. The late awakening to the value of manual training schools is confined almost exclusively to the largest cities. Nothing is done in the smaller towns to teach manual skill or general expertness in the use of tools, and the idea of any public effort to encourage the education of highly skilled mechanics in any department is not thought of. A boy may learn to hold a plow, to shovel dirt, to do common carpenter's work, to paint a house, to shoe a horse; he may learn how to clerk in a store, to become a lawyer, or to sell life insurance; but the country towns are absolutely dead to the need of cultivating the mechanic arts, and teaching the American youth that general knowledge and special skill without which our native workers are being so rapidly driven out of the higher branches of industrial activity. In Switzerland, France, Germany, Belgium, Holland, Austria, the village boy or girl with any aptitude finds a school near by in which he may pursue the lines of study proper to lay the foundation for any art or calling, and in most cases he may then enter a trade school from which, after years of the most thorough practical and technical instruction, he may be graduated a finished master of his chosen trade.

What is to become of the American rural and village population, which is shut out from even the benefits of such manual training as may now be had in the high schools of a few of the most progressive cities? We are fast creating a peasantry, which, in another generation, will seem rude in comparison with the peasantry of Europe, unless we adopt some enlightened method of enabling our workers to compete, man for man, with the artisans of Europe. Prices artificially increased by law may tempt the foreign worker to remove to this country, but a truer protection would seek to make our own mechanic a better man. Practically the Western village boy can neither learn a skilled trade at home nor practice it there; to rise in life, to give scope to his ambition, he must become an exile from his native town.

Much is being said about discontent in the West, and about the growth of sectionalism along new lines. Some deny that there is any such unrest, and they point to the general prosperity of the thriving cities in proof of the statement that the people are in general prosperous. The extreme depression of agriculture cannot be traced to railroad discrimination or to any single cause, but that there is dissatisfaction with such abnormal conditions as exist throughout the North Central States is certain; and it is not strange that the people become impatient with evils which seem wholly unnecessary.

Whatever be the causes of the paralysis with which these communities are stricken, they affect all classes, whether farmers or villagers, but apparently the little industries of the towns suffer most. The people, therefore, in their efforts to understand the real source of the oppression which they realize keenly, but which is so pervasive as to seem almost to belong to the nature of things, rush from one political party to another in search of relief; they embrace in turn all possible vagaries with enthusiasm. This is why populism, which never has had much strength in the cities, is most active in the country villages. The need of some kind of relief is plain enough.

HENRY J. FLETCHER.

STATISTICS OF THE UNITED STATES.

To select with good judgment the most important statistics from voluminous census reports, to tabulate them, draw brief lessons from them and make their story by artful charts and diagrams plain at a single glance, is a most useful task. Such a task has been performed by Mr. Henry Gannett in his book called "The Building of a Nation," published by the Henry T. Thomas Company, New York, which presents a remarkable collection of facts that tell of the growth, the present condition and the resources of the United States. Some of these facts may be wholly novel to many readers, while others become more than ever impressive from the manner in which they are grouped.

When our country had shaken off the yoke of England, its territory was limited on the west by the Mississippi and on the south by the 31st parallel, practically the northern boundary of Florida. This area was augmented in 1803 by the Louisiana purchase for $12,000,000. This gave us 1,171,931 square miles, if we include in the reckoning the large region now constituting the States of Oregon, Washington and Idaho, not a part of that purchase, but acquired as a direct and immediate result of it through occupation and settlement. Next, in 1821, came the Florida purchase of 59,268 square miles, costing $5,000,000; then, in 1845, the annexation of Texas, 375,239 square miles; in 1848, the Mexican cession of 545,783 square miles, costing $15,000,000; in 1853, the Gadsden purchase, at the southern part of what are now Arizona and New Mexico, 45,535 square miles, costing $10,000,000; in 1867, Alaska, 570,000 square miles, costing $7,200,000. Thus, for about $50,000,000 in money, our domain grew from 827,844 square miles in 1790 to 3,603,884 square miles in 1870 and to-day.

But a most striking fact is that, as the population, which was only 3,929,214 in 1790, had increased to 62,622,250 on June 1, 1890, and, indeed, including the people of Alaska and the Indians not then counted, to about 63,000,000, the density of population had grown far more than the area. The latter was in 1890 about four and a half times that of a century before, and yet the density of population in 1790, only 4·75 inhabitants per square mile on the average, had increased to 17·37 per square mile in 1890, even with the vast untenanted regions of Alaska to bring down the average.

But the comfortable growth still possible is shown by the fact that while our country is nearly as large as all Europe, it is exceeded in density of population by every country of Europe except Russia and Norway. And the most populous countries are from 10 to 20 times as thickly settled.

The land surface of the United States has two systems of uplift, the Appalachian and the Cordilleran or Rocky, and with the great stretch of the country in both latitude and longitude, there is a wonderful variety of climate, soil, and vegetation. Nowhere, perhaps, have the forces of nature been exerted upon a more marvelous scale, eroding canons and gorges, forming vast basalt plains, and changing trunks of trees to amethyst, opal, chalcedony, and quartz crystal. The hot springs and geysers for number and magnitude completely eclipse those of all the rest of the world together. Where Iceland has two or three active geysers, petty by comparison, Yellowstone Park alone has hundreds. There are thousands of hot springs, some of them covering areas of many acres, and the amount of boiling water ejected from the earth is almost incredible.

The temperature of the country in the east is fairly uniform, considering the range of latitude, etc., but in the mountain region of the west there are great excesses. "At Yuma, near the mouth of the Colorado River, the temperature in summer often exceeds 115°, and when it falls to 100° people put on their flannels. On the other hand, in Montana, minimum temperatures of minus 52° have been repeatedly recorded; although on the whole the climate of Montana is exceptionally mild, considering its latitude and altitude." Taking the whole land together, "it is one of the wettest and one of the driest countries on the globe; it is one of the hottest and one of the coldest."

The approximate area of the public lands, excluding Alaska, being reckoned at 1,440,000,000 acres, we find that up to June 30, 1892, 873,000,000 acres had been alienated; about 130,000,000 in homesteads, 224,000,000 in cash sales, 79,000,000 in railway land grants patented, 70,000,000 in swamp lands to States, 61,000,000 in land bounties for military service, etc. Of the 567,000,000 acres remaining, perhaps 100,000,000 must be allowed for Indian reservations and about 103,000,000 for grants to railroads not yet patented. Most of the lands not taken up are mountainous or arid.

China is the most populous country on the globe, with 360,000,000 to 385,000,000 people; India is the next, then Russia, while fourth comes our country, and fifth is Germany. Our land has doubled its population in the last thirty years, while in the same period France has increased three per cent. and Great Britain and Ireland twenty-nine per cent. Maine and Vermont are practically not increasing, and Nevada has been actually decreasing. In 1790, Virginia was the most populous State in the Union, with Pennsylvania second. New York in 1810 reached the second place, and in 1820 the first place, Virginia then being second. In 1830, Pennsylvania pushed up to second place again, and has held it ever since. In 1790 the third place was occupied by North Carolina; between 1840 and 1880 it was held by Ohio; while in 1890 Illinois secured it. At that census, New York showed 5,997,853 people; Pennsylvania, 5,258,014; Illinois, 3,826,351; Ohio, 3,672,316. Missouri was fifth with 2,679,184.

The center of population in 1790 was about 23 miles east of Baltimore; in 1800, about 18 miles west of Baltimore; in 1810, about 40 miles northwest of Washington; in 1820, about 16 miles north of Woodstock, Va.; in 1830, about 19 miles southwest of Moorefield, W. Va.; in 1840, 16 miles south of Clarksburg, W. Va.; in 1850, 23 miles south of Parkersburg, W. Va.; in 1860, 20 miles south of Chillicothe, O.; in 1870, 48 miles east of Cincinnati; in 1880, 8 miles west of Cincinnati; in 1890, 20 miles east of Columbus, Ind. Perhaps the most remarkable feature in this march is the directness of its westerly progress. In the full century it has not varied half a degree from a due west direction, or gone north or south of a belt about 25 miles broad. Yet in this century it has moved across more than nine meridians, or a distance of 505 miles westward. In comparison with the center of population we may note the center of area, which, excluding Alaska, is in the northern part of Kansas.

An arbitrary rule must be followed, of course, in determining what is urban and what is rural population. The census office treats as urban all concentrated bodies exceeding 8,000 in number. On that basis it finds that while in 1790 the urban population was but 131,472, and the rural 3,797,742, a century later the former had increased to 18,284,385, while the latter was 44,337,865. The proportion of urban to total population in 1790 was 3·35, whereas in 1890 it had reached 29·20. In fact, in 1790 this country contained but six cities of more than 8,000 people each, while a century later it had 443. The total population had become 16 times as great, but the urban population 130 times as great. The North Atlantic States contain the greatest proportion of the urban element, 51·81 per cent. Rhode Island leading off with 78·80, followed by Massachusetts with 69·90, and New York, 59·50.

In 1870 there were but 14 cities of more than 100,000 inhabitants each. In 1880 there were 20, and in 1890 there were 28. These cities combined had 9,788,150 people, or 15·6 per cent. of the whole population. There were 11 cities at the last census that exceeded 250,000 each. Mr. Gannett notes that within a radius of fifteen miles of the City Hall of New York, and tributary to that city as the metropolitan district is to London, live three and a quarter millions of people, or enough to make it the second city in size upon the globe.

The average size of families has diminished from 5·55 persons in 1850 to 4·93 in 1890, which is over 11 per cent. The highest average is in the Southern States, due primarily to the large proportion of colored people, among whom the birth rate is exceptionally great. But the families of the whites in the South are also larger than the average, and even equal those of the north central States, where the Germans, Norwegians and Swedes increase the average.

As to sexes, the males at the last census numbered 32,067,880, and the females 30,554,370. This is a larger proportion of males than in 1850 or in 1860. The facts show, it is said, a tendency to an increase in the proportion of males, which has exceeded that of females certainly during the last forty years, although the tendency received a setback during the civil war, from which it is now recovering. A table shows that in Europe, while the numbers of the two sexes are nearly equal, the females are in excess, the proportion ranging from 50·58 in the Netherlands to 51·46 in the United Kingdom and 52·10 in Norway. In our country the percentage of females at the last census was 48·79 and that of males 51·21, the excess of the latter being ascribed to immigration. No doubt emigration accounts, also, for some of the figures in European countries; yet in Spain, where there is comparatively little of it, we find but 49·04 males to 50·96 females, and in Austria, where there is not excessive emigration, 48·91 to 51·09.

Of course, the difference between our own States in this matter is great. The factories on the Atlantic border attract great numbers of female operatives, while the outdoor occupations of the West draw many males. In Montana there are two males to one female, and nearly as great a ratio in Wyoming. On the other hand, in New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Maryland, Virginia and both Carolinas, females are in excess, although this excess is not great. In the District of Columbia they constitute 52·44 per cent., and in Massachusetts, which stands next, 51·42.

Of our total of 62,622,250 people at the last census, there were 7,470,040 of negro or mixed blood, including mulattos, quadroons, and octoroons. This is a little over 12 per cent., and it shows an increase from 6,580,793 in 1880, and from 4,880,009 in 1870. Of course, the relative proportion of increase has been greater for the whites. The faulty character of the census of 1870 even aroused some question as to whether the colored element was not relatively losing with enormous rapidity. But Mr. Gannett shows that in the thirty years preceding 1860 it increased 48 per cent., and in the next thirty years not less than 68 per cent. In Louisiana the colored people are about one-half the population; in Mississippi and South Carolina, nearly three-fifths; in the coastwise States, from Virginia to Louisiana, inclusive, over one-third each. It is declared that there has been a "perceptible southward movement of the colored race."

As to the Chinese, their immigration began in 1854, and averaged about 4,000 to 5,000 for fifteen years, when it became more rapid. Agitation produced the Exclusion act of 1882, with the result that, while the census showed 104,168 Chinese here, that of 1890 showed 106,162, only a very slight increase. The Indians numbered 249,273 in 1890, with 216,706 living upon reservations, and more than a third of these were self-supporting and self-governing.

Of our total population at the last census, 9,249,547 were of foreign birth and 53,372,703 of native birth, including the colored races. The native whites numbered 45,862,023. It is interesting to note that the changes have been comparatively small in these proportions in the last thirty years. The native ratio in 1860 was 86·84, of which 73·46 was white; the foreign was 13·16. In 1890 the native ratio was 85·23, with 73·24 of it white, and the foreign was 14·77. Prior to 1860 the native ratio was larger, being 90·32, but the native white ratio is given as only 73·94, or precisely as at the last census.

The leading industry of the United States, if we consider the number of persons employed and supported by it, is agriculture; but if we consider the value of the product, it is manufactures, since the latter in 1890 exceeded $4,000,000,000, while that of agriculture was only $2,460,000,000. A very striking fact is that in 1880 the net product of manufactures was $1,973,000,000, or less than that of agriculture, which was $2,213,000,000 at that time. The enormous gain

and present status of manufactures certainly suggest their right to be heard as an element in the finance of the country. The value of farms in 1890 was $13,276,000,000, an increase of 30 per cent. Farming tools and machinery brought the total capital up to $13,770,000,000, which produced a return of $2,460,000,000, or a little less than 18 per cent. The average size of farms decreased from 203 acres in 1850 to 134 acres in 1880, but in 1890 it increased to 137 acres.

Tobacco is produced in forty-two States and Territories, but nearly half the whole crop comes from Kentucky. Virginia, Ohio, North Carolina, Tennessee, and Pennsylvania are also great producers, as, too, are Connecticut, in proportion to its area, and Wisconsin, considering its latitude.

Wheat is the most important of our cereal crops, and in the famous year 1891 the yield was 612,000,000 bushels, whereas India produced only 235,000,000; France, 231,000,000; Russia, 186,000,000; Hungary, 119,000,000; and Italy, 102,000,000. That year was also a great one for our corn, which reached 2,060,000,000 bushels, falling off about one-fifth the following year. Of oats, during that same prosperous year, the production reached 738,000,000 bushels. The rye crop is generally heavy, while barley and buckwheat come lower on the list.

Cotton, of course, is of great importance, the maximum yield, that of 1892, reaching 9,038,707 bales, Texas leading off by virtue of its area, while Georgia and Mississippi are enormous producers, with Alabama following. Hay is a product of vast value, that of 1888 amounting to 47,000,000 tons, valued at $408,000,000; and mention must also be made of potatoes, of which the product in 1888 was 202,000,000 bushels, valued at $81,000,000.

The total number of farm animals in 1892 was 169,100,000, valued at $2,461,000,000. Horses led off, with 15,500,000 in number and $1,008,000,000 in value. Cows numbered 16,400,000, with a value of $570,000,000. The densest sheep population is in Ohio, averaging 109 to a square mile, or nearly three times as many for the area as any other State. Of hogs, Iowa has 127 to the square mile; Illinois, 85; Ohio, 69.

In about two fifths of the area of the country, excluding Alaska, the rainfall is not adequate for agriculture, so that in eleven States and Territories irrigation is resorted to. The total area irrigated, at the date given, was 3,564,416 acres, or about one-half of one per cent. of the total area. In two States, Colorado and California, the irrigated area exceeded one per cent.

Manufactures have had a rapid development in this country. In 1850 the capital employed was $533,000,000; the hands, 957,000; the wages, $237,000,000; the material, $555,000,000; the gross product, $1,019,000,000; the net product, $464,000,000. These figures fell somewhat short of doubling in 1860. However, in 1880 all of them had been more than quadrupled, except the number of hands, which was about tripled. For 1890, by making approximate calculations from partial statistics, Mr. Gannett reaches these vast figures: Capital, $6,180,000,000, or nearly twelvefold that of 1850; hands employed, 4,665,000, or nearly fivefold, in spite of the introduction of labor-saving machinery; wages, $2,000,000,000, or nearly ninefold, thus making the average wages far higher; gross product, $9,400,000,000, or over ninefold; material, $5,000,000,000, or ninefold; net product, $4,400,000,000, or nearly tenfold. In ten years the South has made great strides in manufactures.

The average yearly wages of employes in 1850 were $247; in 1890 they were $429. The average capital invested in each establishment had also increased from $4,000 to $15,000. In 1850 the proportion of net product going to employes was 51, and to capital 49; in 1890 these proportions had become 45 and 55 respectively. But in 1850 the proportion of net product to capital was 87, and, minus wages, it was 43; whereas in 1890 these proportions had respectively diminished to 71 and 39.

New York is our greatest manufacturing center, with over $750,000,000 of products in 1890; then follow Chicago, with over $600,000,000; then Philadelphia. After a long gap, come Brooklyn, St. Louis, Boston and then Cincinnati.

Of steel we now produce one-fourth more than even Great Britain herself; and of iron in 1890 and the two years following, we produced 12 per cent. more. On June 30, 1890, we had 562 blast furnaces, 294 of them in Pennsylvania, and also 158 steel works, about half in Pennsylvania.

Of cotton factories we had 904 in 1890, with $354,000,000 capital, employing 221,585 hands, or an increase of 27 per cent. over 1880, and earning $66,000,000 in wages, an increase of 57 per cent. The product had risen to $268,000,000, an increase, in ten years, of 40 per cent. New England carries on 63 per cent. of the cotton manufactures.

Woolen factories had in 1890 fallen off in numbers from 1880, but they had increased their capital invested from $159,000,000 to $297,000,000, their gross product to $338,000,000, and their wages from $47,000,000 to $66,000,000, or 62 per cent., although the net product, owing to the increased cost of raw material, had scarcely increased at all.

There were 18,536 periodicals of all classes published in 1891. In the same year were produced 44,316,804 gallons of whisky, 12,260,821 of alcohol, 24,306,905 of wines, 1,784,312 of rum, 1,223,775 of fruit brandy, and 30,021,079 barrels of beer.

Our mineral product for 1891 is put at $668,524,537, an enormous total. It included $117,106,483 in bituminous coal; $128,337,985 in pig iron; Pennsylvania anthracite, $73,943,735; building stone, $47,294,746; silver, at coining value, $75,416,565; gold, $33,175,000; copper, value at New York, $38,455,300; lime, $35 000,000; petroleum, $32,575,188; natural gas, $18,000,000; lead, $17,609,322; while zinc, cement, salt, phosphate rock, mineral waters and quicksilver add to the amount. We produce a third of the world's coal and one-fourth of its iron, Great Britain alone exceeding us. We produce one-third of the world's steel, surpassing her. We produced in 1890 about 28 per cent. of the world's gold, and used to produce more, the yield in 1853 being $65,000,000. We produce two-fifths of the world's copper, and by far the greatest part of its petroleum. As to transportation, our railways have a greater mileage than those of all Europe combined.

Such are a few of the facts concerning the land we live in.—N. Y. Sun.

A MODIFICATION OF THE ORDINARY ELLIPSOGRAPH, WHICH SERVES TO DESCRIBE A SPHEROCONIC.

IN the arrangement of a bar, moving with one end on a horizontal ellipse, the other on a vertical bar, through the center of the ellipse, the center of the moving bar describes a spheroconic.

Since A O B is a right angle, C moves on a sphere.

If M be the middle point of O A, then M describes an ellipse similar to A, hence C M describes an elliptic cylinder, C M being always vertical.

The curve described by C is the intersection of a sphere and an elliptic cylinder.

Let the equation of the sphere be

$$x^2+y^2+z^2=1 \qquad \text{(i)}$$

and the cylinder be

$$\alpha x^2+\beta y^2=1 \qquad \text{(ii)}$$

The intersection of (i) and (ii) is

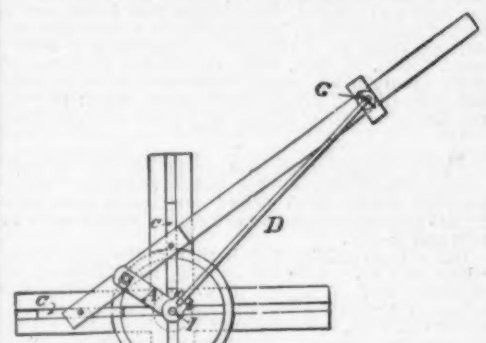
$$x^2(1-\alpha)+y^2(1-\beta)+z^2=0$$

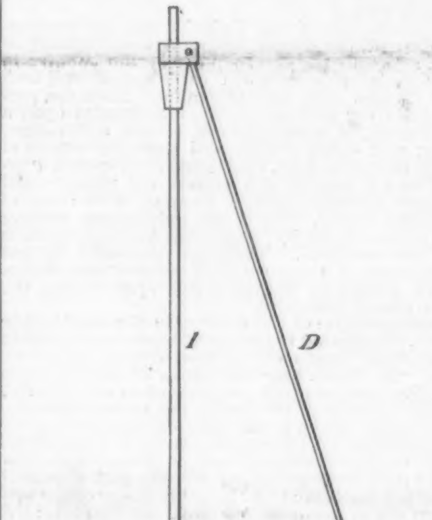
which is the equation of a quadric cone.

The point C, therefore, describes a spheroconic.

One of two difficulties presents itself in the mechanical construction, viz., a "dead point," or the liability of parts to interfere.

These difficulties are overcome by a modification of the ordinary elliptic compasses or ellipsograph.





This modification consists of the addition of two bars, one vertical to the center of the ellipse (A), the other from the generating point (A) to the vertical bar.

By choosing the ellipsograph, the first of the two difficulties is obviated, and now the liability of interference is to be contended with.

If nothing but the two bars be added, then the vertical bar interferes with the working of the ellipsograph.

In the ellipsograph the center of the distance between the two slides describes a circle.

If, now, a double crank (A B) be attached in such a manner as to have its bearings entirely below the slides (C), with the axle of the crank passing through the middle point of the bar joining the slides, we can fasten the bar (I) to this crank so that it will remain vertical over the center of the ellipse.

We may substitute for the lower arm of this double crank a ring (B). Then by means of a worm engaging the periphery of the ring may impart continuous motion, thus enabling us to see the curve continually described.

As to the curves described by a point C' not at the middle point of A B, but dividing it in a given ratio, it is clear that the plan of this curve is an ellipse similar to A and M; that is, that the curve lies on a vertical elliptic cylinder.

Again, if the rod A B were capable of taking all positions, such that A lies in the horizontal plane and B lies on the vertical B O, the locus of C' would be an ellipsoid of revolution. Accordingly the curve described by C' is the intersection of the cylinder and the ellipsoid of revolution.

It should be added that an apparatus recently constructed as described works satisfactorily.

J. OSCAR VILLARS.

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